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MGIPC—M—IV-2-61—21-2-27—650.

A CONTRIBUTION TOWARDS A MONOGRAPH OF THE INDIAN CONIOPTERYGIDÆ (NEUROPTERA).

BY

C. L. WITHYCOMBE, Ph.D., M.Sc., D.I.C.

AGRICULTURAL LIBRARY INSTITUTE

(Received for publication on 27th January 1925.)

Mr. T. Bainbrigge Fletcher has been so kind as to forward to me for determination the whole of the material of Indian Coniopterygidæ contained in the Collection of the Agricultural Research Institute, Pusa. This collection I had long hoped to see, as the Indian Coniopterygidæ have received very scant attention from entomologists. Only one species has been described from the entire mainland of India, and one from Ceylon. Hagen[1] described *Coniopteryx cerata* from Ceylon in 1858. Lefroy[2] in 1909 mentioned Coniopterygids as having been taken at Surat and Simla, but no description was given. Banks[3] in 1913 described the first Coniopterygid from India proper, under the name of *Malacomyza terminalis*, the specimens having been taken by Mr. Bainbrigge Fletcher at Belgaum, Bombay Province, in 1910. Thus, as compared with our knowledge of Coniopterygidæ from other parts of the world, that of Indian Coniopterygidæ was extremely limited.

In the present paper eleven species are described as new. A new genus is proposed for *M. terminalis*, Bks. These are all from material in the Pusa Collection. A note upon the male and cocoon of *Coniopteryx cerata*, Hag., has been added, and the male genitalia of this species are figured for the first time.

Of the Pusa material there remain two specimens of a very small *Coniopteryx*, which, owing to their bad condition, I do not wish to describe. They bear the following labels :—

1. Shevaroys—Yercaud. 23 April—4 May. 13, 4,500 feet, Fletcher Coll.
2. On mushroom, Pusa, Bihar, Umrao Bahadur, 10. I. 16. C. S. 106.

The Coniopterygidæ are small Neuropterous insects with a somewhat reduced system of wing venation. The body is covered to a greater or less extent with a white waxy powder which is secreted by hypodermal glandular areas on the body

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[1] Hagen, 1858. *Coniopteryx cerata* sp. n. *Verh. zool.-bot. Ges. Wien*, VIII, p. 484.
[2] Lefroy, 1909. *Indian Insect Life*. Calcutta. 786 pp., p. 156.
[3] Banks, 1913. *Malacomyza terminalis*, n. sp. *Trans. Amer. Ent. Soc.*, XXXIX, p. 220.

and is rubbed over the body and wings by the insect shortly after emergence. In this respect, therefore, Coniopterygidæ resemble the Aleurodidæ, and they are frequently mistaken for the latter. The following are the main points of difference :—

Aleurodidæ.	*Coniopterygidæ.*
Antennæ small, 7-jointed as a rule. Mouthparts prolonged into a sucking rostrum or beak. Tarsus 2-jointed. Wing venation very simple. In the living insect the wings are held rather flattened and outspread when at rest.	Antennæ longer, more than 15-jointed. Typical biting mouthparts. Tarsus 5-jointed. Wing venation simple, but more complex than that of Aleurodids. In the living insect the wings are held more steeply roofed over the body.

The classification of the Coniopterygidæ is based on wing venation. Characters so derived are usually reliable for generic determination and often for specific, but in certain species the position of cross-veins is exceedingly variable.

The system of venational terminology here adopted is that of Comstock and Needham. Comstock[1] gives a figure of the venation of *Semidalis* which serves well to indicate the nature of the various veins. It should, however, be pointed out that the apparent cross-vein from Sc to R_1 and the terminal portion of R_1 are to be regarded as Sc_2. This has been shewn in *Conwentzia*[2] and I have since been able to confirm it for *Semidalis.*

The number of antennal joints often serves as a good specific character. It is generally variable within limits. Greatest range of variation is seen in those species of which the antennal joints number thirty or more.

The tarsal ratio of the hind legs has been used by Enderlein and is valuable in some species, but it is unfortunately not so constant and reliable as one would wish.

The male genitalia appear to afford the most invariable characters of all and wherever possible it is advisable to have males for comparison in making determinations. For the proper examination of the genitalia it is necessary to make balsam preparations subsequent to treatment with caustic potash. The male genitalia of Coniopteryginæ are built upon much the same plan throughout, with a pair of penis sclerites, to the internal extremities of which are attached muscles in such a way that the sclerites can be everted and their external hooks used in grasping. Often there is a central intromittent organ. In the Aleuropteryginæ, on the other hand, judging by the two males examined, the tendency seems to be to the reduction of penis sclerites as grasping hooks and to the greater development of a central chitinous cylinder which may possibly be used as an intromittent organ. It is withdrawn well within the body at rest and can probably be everted considerably (Figs. 6 and 7).

Biology. Coniopterygidæ seem to occur principally on trees or shrubs and are not found as a rule on low vegetation. They prey upon small Rhynchota and Mites. The adults also feed on honeydew, etc.

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[1] Comstock, 1918. The Wings of Insects. New York. p. 212.
[2] Withycombe, 1922. The Wing Venation of the Coniopterygidæ. *Entomol.*, LV, pp. 224—225.

Eggs (Fig. 1) are white to orange in colour. They are usually laid singly at the edges of leaves and are oval, often somewhat flattened, and pointed at the micropylar pole. The chorion is sculptured with a honeycomb-like pattern.

The larva (Fig. 2) is shortly spindle- or top-shaped, covered only with fine hairs. The head is small, rounded and inconspicuous, with eyes consisting of groups of five simple elements. Antennae are two-jointed, the basal joint being short and the distal portion elongate and plumose with fine hairs. The mouthparts are in the form of a cone covered above by the labrum, but in *Aleuropteryx*[1] the sucking spears are rather elongate and they are only covered basally by the labrum. Labial palpi are more or less club-shaped and are three-jointed.

The thorax and abdomen merge into one another, tapering at the extremity of the latter. Legs are well developed for walking, but the tarsus is composed of only one segment. There are two tarsal claws.

The larva feeds voraciously on Mites, such as red spider, and small Rhynchota. Towards the end of active life it spins a flat circular cocoon, of silk which is secreted by the modified Malpighian tubes, using the anal extremity as a spinneret. This cocoon is generally spun upon the bark of the tree or on the flat underside of a leaf. It is often of double structure, there being an outer and an inner envelope. In *Coniopteryx cerata*, Hag., from Ceylon, the cocoon is drawn into radial ridges dorsally.

The pupa has all the appendages fairly free and would be termed a *pupa libera*, but it does not move until just before emergence. Then it cuts a semi-circular slit in both envelopes of the cocoon with its pupal mandibles and may walk completely out of the cocoon or the adult may emerge from the pupal skin while still projecting slightly from the cocoon. The wings are extended and dried, and the waxy powder secreted from the body glands is rubbed over them by the hind legs. Other particulars as to the biology of Coniopterygidæ have already been given.[2]

Economic Importance. The Coniopterygidæ are to be considered as entirely beneficial to the agriculturalist since both as larvae and as imagines they are predaceous upon Rhynchota, Mites, etc., and they are often very abundant locally. Unfortunately, they are rather liable to be confused with Aleurodidæ : the principal distinguishing characters have already been indicated. The importance of the Coniopterygidæ from an economic standpoint and their possible utilisation has been more fully discussed elsewhere.[3]

Collecting and Mounting. Coniopterygidæ may be collected by beating trees and shrubs and by other ordinary methods. The imagines do not fly much and are feeble on the wing. Apparently the males alone are attracted to light. Larvae

[1] Löw, 1885. Beitrag zur Kenntniss der Coniopterygiden. S.-B. *Akad. Wiss. Wien, math.-nat.* Cl., XCI, Abt. I, pp. 73—88.

[2] Withycombe, 1922. Notes on the Biology of Some British Neuroptera. *Trans. Ent. Soc., London*, pp. 501—594.

[3] Withycombe, 1924. Note on the Economic Value of the Neuroptera, with special reference to the Coniopterygidæ. *Ann. App. Biol.* XI, No. 1, pp. 112—125.

occur upon trees and shrubs but are difficult to detect. They are not easy to rear in captivity, but if captured when full fed they will spin up, pupate and emerge without difficulty. Cocoons may be found upon the bark of trees and the undersides of leaves. Imagines can easily be bred from these. Being extremely fragile, captured Coniopterygids are best brought home alive or in spirit. If killed in the field they are very liable to damage unless carefully packed.

The white waxy powder covering these insects has been mentioned by Enderlein as being of some value in systematic work, but this value is quite insignificant and for specific determination it is better to rely on structural characters. The writer prefers to bring specimens home alive in small boxes and, after noting superficial characters, colour, etc., to preserve in 70 per cent. alcohol; or small tubes ($\frac{1}{8}\times 1$ inch) have been used to isolate specimens after killing in the field. Coniopterygidæ are difficult to pin, on account of their small size, and often a dry specimen cannot be determined. It is therefore necessary to make microscopic preparations, as from such alone can one observe many structural characters.

Enderlein[1] recommends mounting one pair of wings dry and the other pair in balsam. The body of the insect is then treated with cold caustic potash solution over a period may be of some days. I find that prolonged maceration in cold potash softens the chitin to a much greater extent than does boiling in an even stronger solution for a few minutes, and the disadvantage of such softening is manifested when transferring to balsam; the legs and antennae are not sufficiently rigid to resist external pressure when the clearing medium diffuses out of the insect and into the balsam, thus resulting in the collapse and shrinkage of these appendages. This very annoying occurrence is frequent and the only remedy is to take the specimen back again into alcohol and then much more gradually into balsam.

Personally I find the following routine best. The specimen is mounted on one slide in parts under two No. 1 circular coverslips of 1 cm. diameter. A pair of wings may be mounted dry under a third coverslip, but this is not really necessary if any striking peculiarities of the wax powder have first been noted. The powder cannot be used for specific determination. I usually mount both pairs of wings under one coverslip as follows. Place the specimen in absolute alcohol or in n-propyl alcohol and with a pair of needle-pointed forceps remove the wings of one side. Place a very small drop of camsal balsam (Gilson's formula) on a microscope glass slip to the left of the centre and in this drop of balsam place and arrange the wings. Now remove and arrange the wings of the other side in opposition to the first pair. It will be found that the camsal balsam dries fairly quickly and thus fixes the wings in position. Should the balsam set too quickly, add a fraction of a drop of n-propyl alcohol if it is required to reset the wings. This will soften the balsam and the wings can then be rearranged. Put aside the slide to set completely and to dry under a bell glass free from dust.

[1] Enderlein, 1906. Monographie der Coniopterygiden. *Zool. Jahrb.*, XXIII, Abt. f. Syst., pp. 173—242.

Now transfer the body to 10 per cent. potassium hydroxide in water and boil for two or three minutes until cleared. I use a short test tube $\frac{5}{8} \times 3$ inches, over the mouth of which is fastened a piece of fine gauze to prevent loss of the specimen by spurting of the potash. Spurting can be avoided if heating is conducted carefully and if a fresh quantity of solution is used each time, but it is advisable to take precautions against mishaps. When the specimen is cleared it is transferred to glacial acetic acid and is then brought to the boil to drive off any bubbles of carbon dioxide which may form, due to the presence of some potassium carbonate in the potassium hydroxide. (Personally I use a small silica crucible, with an inverted watchglass as cover, for this heating. The acetic acid condenses and drops back into the vessel from the centre of the watch-glass. Heating can be done rapidly without fear of cracking the vessel. A silica vessel cannot, of course, be used for boiling potash). After cooling, the cleared specimen is transferred from acetic acid, which dehydrates, to n-propyl alcohol or finally to amyl alcohol. I much prefer the latter as a final bath, even though preceded by propyl or other alcohol. Amyl alcohol is not very hygroscopic, and can therefore be used with advantage in the rainy season ; also its density more nearly approaches that of the camsal balsam, and it does not diffuse out of the specimen too rapidly, so that shrinkage is hardly likely to occur on transference to balsam. After allowing to remain in amyl alcohol for about ten minutes, the specimen may be transferred to a drop of camsal balsam placed on the slide,—this time to the right of the centre. Here the specimen is arranged and the balsam again allowed to set, under a bell jar. Before the balsam sets, the maxillae and labium are removed, if required. This can easily be done with a finely sharpened needle under a Greenough binocular microscope. Push the needle into the mouth of the insect between the mandibles, press downward on to the slide and draw out the labium and maxillae together. The mouthparts sometimes afford good characters.

When the balsam has set completely, *i.e.*, after twenty-four hours or so, a fresh drop of balsam is added and a coverslip is lowered on to each drop. The slide is again put aside to set for a day or two.

By this method well spread preparations can be obtained which are easy of determination and which lend themselves to camera lucida drawing.

I now use camsal balsam, Gilson's formula in n-propyl alcohol, entirely for Coniopterygidæ. Its low refractive index, 1·478, is valuable as it increases the visibility of unstained chitinous structures. The medium is not easily affected by a damp climate. It sets rapidly ; an advantage in fixing specimens to the slide. When set hard it can be dissolved if necessary in any serially lower alcohol than n-propyl.

Key to Genera of Indian Coniopterygidæ.

A. Media of forewings with two prominent bristles near the middle. Media in hindwings running for more than half its length closely applied to or fused with the fore-cubitus, Cu_1. Galea of maxilla 3-jointed. Abdominal ventral sacs present.

Sub. Fam. **Aleuropteryginæ.** (Figs. 3—7 and 17, 18).

B. Lower arm R_{4+5} of radial sector in forewings attached to media in such a way as to give it the appearance of being a branch of media. Media in fore and hindwings forked. Wings of fairly normal shape and not strikingly fringed.

—— *Niphadicera*, gen. nov. (Figs. 3—6 and 17).

BB. Fork of radial sector normal. Media in both fore and hindwings simple and not forked, Wings narrow, curved and sub-acute, fringed with long hairs.

—— *Coniocompsa*, End. (Figs. 7 and 18).

AA. Media in forewings without two more conspicuous bristles. Media in hindwings not closely applied to forecubitus Cu_1. Galea of maxilla composed of a single segment. No abdominal ventral sacs.

Sub. Fam. **Coniopteryginae.** (Figs. 19-28).

B. Hindwings reduced in size.

Conwentzia, End. (Fig. 19).

BB. Wings sub-equal, *i.e.*, hindwings normal.

C. Radial sector unbranched in both fore and hindwings.

Nimboa, Nav. (Figs. 20 and 21).

CC. Radial sector forked in fore and hindwings.

D. Media in hindwings simple and not forked.

Coniopteryx, Curt.* (Figs. 22—25).

DD. Media in hindwings forked.

Semidalis, End. (Figs. 26—28).

NIPHADICERA, gen. nov.

Genotype *Malacomyza terminalis*, Banks, ♂.

(Figs. 3-6 and 17.)

An examination of a male "cotype" (strictly paratype) of Banks' species shows that *Malacomyza terminalis*, Bks., belongs to the sub-family Aleuropteryginæ and not to the Coniopteryginæ, for the following reasons.

The galea of the maxilla is three-jointed (Fig. 4). There are four pairs of abdominal ventral sacs (Fig. 6). The male genitalia are of typical form (Fig. 6). The media in the hindwings fuses with the fore-cubitus for about half its length (Fig. 17).

The new genus *Niphadicera* may be distinguished by the curious basal joints of the antennae in the male, which are similar to those of *Niphas*, End. (Fig. 3);

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* In using the name *Coniopteryx*, Curtis, I have followed Enderlein.[1] Banks,[2] on the other hand, with good reason, prefers the name *Malacomyza* Wesmael. The difficulty has arisen through a mistake of Curtis. This last author[3] has given a poor and hardly adequate description of his genus *Coniopteryx*, but he has added a good and unmistakeable figure of another genus (*Semidalis* End.). One has to decide whether to accept the good figure or the poor description as that of *Coniopteryx* Curtis. Personally, since authors cannot be held responsible for artists' vagaries, I prefer to follow the bad description, and therefore I have used Enderlein's name *Semidalis* for the genus figured by Curtis, while retaining the name *Coniopteryx* for the genus described.

[1] Enderbin, 1906. Monographie der Coniopterygiden. *Zool. Jaharb.*, XXIII, Abt. f. Syst., pp. 173-242.

[2] Banks, 1907. A Revision of the Nearctic Coniopterygidæ. *Proc. Ent. Soc. Washington*, VIII, pp. 77—86.

[3] Curtis, 1834. British Entomology, XI, p. 528.

by the cross vein Rs to M being placed near origin of Rs and striking M more basad than origin of Rs; by the cross vein M to Cu_1 being placed before level of origin of Rs (Fig. 17); by the complete fusion of M and Cu_1 for some distance in the hindwing; and by several minor characters, described below, taken as a whole.

There are four pairs of abdominal ventral sacs as in Coniocompsini. The wing venation appears to be intermediate between Aleuropterygini and Coniocompsini. The male antennal character may possibly be present in other Aleuropteryginæ, but in *Aleuropteryx* it is the second joint of the antenna of the male which is modified.

It is unfortunate that Banks has selected a female as holotype of his species, but he briefly refers to what he considers to be the corresponding male. While there is probably no doubt as to the correct assignation of this male to Banks' species *terminalis* yet in view of the possibility I consider it advisable to give below a description of the male "cotype" upon which my genus *Niphadicera* is based. Banks' own description of his species is appended. From this latter I am inclined to differ slightly on the matter of wing venation.

Description of male "cotype" of *M. terminalis*, Banks, (det. N. Banks) genotype of *Niphadicera*, gen. nov.

Testaceous, covered with white powder.

Head brownish (Fig. 3). Eyes dark brown. Antennae 18-jointed. The basal, first six joints are pale. The seventh joint is darkened and the next ten joints are brownish-black. The last joint is of pale colour. The basal joint of each antenna is much enlarged and elongated. It is hollowed dorsally and in this hollow area are pits bearing each a short hair. The latero-dorsal portions of the frons grow out as curved, horn-like projections (Fig. 3) and on the antero-ventral concave faces of these are situate some closely placed pits larger than those of the antennae and devoid of hairs. Each pit is surrounded by a ring of minute projecting dots and outside this ring is a distinct margin. This pit-area of the frontal cornua is clearly a grasping surface.

Maxillae (Fig. 4) having lacinia with some stiff curved bristles internally at apex, galea three-jointed, palpus five-jointed, the first four joints being dark brown and the terminal joint paler. Labial palpi (Fig. 5) wholly pale in colour.

Remainder of body and legs testaceous. Genitalia very peculiar (Fig. 6) and wholly retractile, with a central eversible portion which is almost completely tubular and which bears distally some sensory hairs. Hind tarsal ratio of legs $8 : 2 : 1\frac{1}{2} : 1\frac{1}{2} : 3$.

Wings pale, with a very slight brownish tinge (Fig. 17). Venation pale. Margins of wings minutely ciliated, the cilia being longest in the anal angle of hindwings.

In the forewings the origin of Rs from R is indistinct and an indistinct cross-vein unites Rs, near its origin, with M. Rs is apparently unbranched, but actually the origin of R_{4+5} appears as a very faint cross-vein. The terminal portion of R_{4+5} appears to belong to M. Cross-veins Sc to R_1 (=Sc_2) and R_1 to Rs are very pale and hardly visible. They are placed almost opposite each other. On the basal half of M are placed two prominent bristles, as is common in Aleuropteryginae. Cu_1 and Cu_2 run near together basally.

In the hindwings cross-veins Sc to R_1(=Sc_2) and R_1 to Rs are placed apart. Rs arises very near base of wing and forks only near apex of wing. M is fused with Cu_1 for much of the basal part of its length. Origin of M_{1+2} hardly visible. Cu_2 and anal veins weak.

Length of body	2·2 mm.
Length of anterior wing	2·3 mm.
Length of posterior wing	2 mm.

Habitat. Bombay Prov., Belgaum ; 2,500 feet ; 12 Aug. 1910, T. B. F.

In Coll. Pusa Research Institute.

Banks'[1] description of *Malacomyza terminalis*, Bks., is as follows :—

> " Densely clothed with white powder, cilia white. Antennae white on basal seven joints, beyond deep black ; palpi black on base, white on last joint ; body brownish, with white powder. Forewings with cross-vein just before fork of the median vein ; radial sector geniculate at base ; in hindwings but one fork. In the male the antennae are thick, the basal joint enlarged at tip, and seen from the side with concave upper edge ; on the head of male is a swollen cap or top piece ; in the female the head is normal, and the basal joint of the antennae long, but not enlarged at tip ; legs with fusiform tibiae.

Expanse 4 mm.

Type.—♀. From Belgaum, Bombay Province, India, 12th August, 2,500 feet. "

In this description I would point out that of the forewing Banks says " with cross-vein just before fork of the median vein ", but his figure shows the cross-vein to be placed distally to the fork of M. One of the characteristics of my genus *Niphadicera* is that the cross-vein Rs to M is situated well basad and not near fork of media. Again, Banks says " in the hindwings but one fork ". This also I would query. I consider these to be errors such as are inevitable from the examination of dry material alone. I define the genus *Niphadicera* from the male " cotype " of *terminalis*, Banks (teste Banks) examined by me. It must be left to future workers, having access to the holotype, to decide whether the type of *terminalis*, Bks., is correctly placed in this genus.

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[1] Banks, 1913. *Malacomyza terminalis*, n. sp. *Trans. Amer. Ent. Soc.*, XXXIX, p. 220.

The structure of the male antennae in *Niphadicera* is clearly useful for grasping, by opposition of the basal antennal joints to the concave pit-area on the lateral frontal projections of the head. Probably the pairing is similar to that which I have described in *Parasemidalis*[1] where the male grasps the female from below. Probably the male *Niphadicera* grasps the hind coxae or femora of the female with his antennae. (This method of pairing is certainly peculiar, if it occurs, and it is comparable with that of some Entomostraca.)

Coniocompsa indica, sp. n.

(Figs. 7 and 18.)

Pale brown; wings mottled with darker. Hindwings conspicuously fringe d White powdery covering of insect not very dense. (This probably varies.)

Head rounded, fuscous in colour. Eyes blackish. Antennae short, dark brown, 21-jointed. Each joint, except first two and last, is shorter than broad. Palpi pale brown, maxillary palpi about twice the length of labial. Lacinia of maxilla with seven, strong, tooth-like setae.

Thorax fuscous, with diffuse brown spots on shoulders of meso and metathorax. Abdomen pale, with only three pairs of ventral sacs. Genitalia as figured (Fig. 7) with a pair of forcipiform gonopophyses.

Legs dusky. Hind tarsal ratio in preparation apparently 13 : 3 : $1\frac{1}{2}$: 2 : 4.

Wings (Fig. 18) of shape and venation typical for *Coniocompsa.*[2] The forewing membrane is largely hyaline, but shows small, pale brown blotches mainly towards the apex and along the inner margin. The two large median bristles are borne on dark brown prominences of the vein. Hindwings hyaline, with the apex slightly tinged fuscous. The inner margins of both pairs of wings are fringed with long hairs, especially the hindwings.

Length of body	2 mm.
Length of anterior wing	2·1 mm.
Length of posterior wing	1·85 mm.

Habitat. Pusa, Bihar, 4-i-16, C. S. Misra.

Holotype ♂ in British Museum (Natural History).

This species differs from both the previously described species of *Coniocompsa*, *C. vesiculigera*, End., and *C. japonica*, End., principally in the greater number of antennal joints and in the slight amount of brown pigmentation of the wings.

Paratype. Damaged (? sex). This agrees with holotype in all essentials.

Pusa, Bihar, 3-iii-15, T. Bainbrigge Fletcher.

[1] Withycombe, 1922. Notes on the Biology of Some British Neuroptera. *Trans. Ent. Soc. London*, pp. 501—594.

[2] Enderlein, 1906. Monographie der Coniopterygiden. *Zool. Jahrb.*, XXIII, Abt. f. Syst., pp. 173—242.

Conwentzia inverta, sp. n.

(Figs. 8 and 19.)

Testaceous, covered with white powder.

Head and palpi pale brown, antennae darker. Eyes black. The antennae have the two basal joints paler, beyond which the joints are dark brown in colour. Number of antennal joints thirty-three. Palpi lighter in colour than antennae.

Thorax, legs and abdomen pale brown; genitalia (Fig. 8) slightly darker. Hind tarsi appear to be only four-jointed although the other tarsi are as usual five-jointed. (This appearance is probably due to a faulty preparation, as the chitin shows some signs of collapse and the last joints are likely to be telescoped into one another.) The ratio of the joints visible is $9 : 2\frac{1}{2} : 2 : 3\frac{1}{2}$, representing the proportionate lengths of tarsal joints Nos. 1, 2, 3, and 5.

Forewings much larger than hindwings (Fig. 19). Veins fuscous, membrane tinged with fuscous. Towards the inner margin of wings this pigmentation fades and at the margin even the veins are invisible. In forewings Sc_2 crosses to R_1 before the point where cross-vein R_1 to Rs strikes R_1. This is a most unusual feature in Coniopterygidae although it is also found so in *Coniocompsa*. Cross-vein R_2 to Rs strikes the latter at its fork point. In the neighbourhood of this cross-vein the wing membrane is most darkly pigmented with brown, but the greater part of the cross-vein is indicated by a colourless streak. Owing to the lack of pigment cross-vein Cu_2 to 1st A is barely visible. It is, however, placed more proximally than cross-vein Cu_1 to Cu_2.

Hindwings reduced. Sc does not appear confluent with R_1. Rs is simple and unbranched. There is a cross-vein from Rs to M, although not very distinct.

Length of body	1·6 mm.
Length of anterior wing	2·5 mm.
Length of posterior wing	1 mm.

Habitat. On Cane, Pusa, India, 23-xi-14, C. S. Misra.
Holotype ♂ in British Museum (Natural History).

Nimboa basipunctata, sp. n.

(Figs. 9 and 20.)

Testaceous. Entire insect covered with white powder and showing darker blackish spots.

Head rounded, pale, with eyes blackish. Antennae pale, 26-jointed, the basal joint largest, second joint smaller, and rest almost equal. Palpi slightly darker in colour than antennae.

Remainder of body testaceous, but thoracic sclerites and genitalia of a darker brown. Male genitalia as figured (Fig. 9).

Legs pale brownish ; fore tibiae very hirsute apically and internally, fore femora do not show a very strongly developed row of setae. Hind tarsal ratio 10 : $2\frac{1}{2}$: $1\frac{1}{2}$: $1\frac{1}{2}$: 3.

Wing venation pale. Marginal hairs on wings minute. In the forewings (Fig. 20) the distal portion of Rs bends anteriorly towards R_1. Rs is unbranched. The faintly indicated cross-vein from Sc to R_1 (really Sc_2[1]) is in a line with the cross-vein R_1 to Rs. Cross-vein from M to Cu_1 leaves the former well before its fork point. At the margin of wing, at the extremities of Rs, M_1+2, M_3+4, Cu_1 and Cu_2, are small, dark brownish pigment spots in the membrane. Another pigment spot occurs at the fork point of M, and a seventh spot basally on Cu_2. Cross-veins are also pigmented.

Hindwings wholly pale, testaceous. Sc_2 is not opposite cross-vein from R_1 to Rs but is placed slightly more distally. Rs is unbranched. Cu_2 and anal vein very weak. Three cross-veins in a curved line connect Cu_1, Cu_2 and A to margin basally.

Length of body	2 mm.
Length of anterior wings	2·3 mm.
Length of posterior wings	1·9 mm.

Habitat. Pusa, Bihar, 4-iv-08, C. S. Misra.

Holotype ♂ in British Museum (Natural History).

This species differs from *Nimboa guttulata*, Navas, in the disposition of Sc_2, in the anterior curving of the apex of Rs, and also in the presence of a basal pigment spot upon Cu_2.

Paratypes. (1) ♀. This female is similar to the male except for the absence of genital armature, also the antennae are 24-jointed, and in the wings Sc_2 leaves Sc slightly before cross-vein from R_1 to Rs.

Length of body	2 mm.
Length of anterior wings	2·2 mm.
Length of posterior wings	1·8 mm.

Habitat. Pusa, Bihar, ix-08, C. S. Misra, F. 49.

(2) sex ? A damaged specimen.

Pusa, Bihar, 4-iv-08, C. S. Misra.

Nimboa immaculata, sp. n.

(Fig. 21.)

Testaceous. Whole insect covered with usual white waxy powder. Immaculate.

Head rounded, pale brown. Eyes black. Eleven joints only of right antennae present, these being fuscous ; rest of antennae missing. Palpi fuscous.

[1] Withycombe, 1922. The Wing Venation of the Coniopterygidæ. *Entomol.*, LV, pp. 224—225.

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Thorax and abdomen yellowish-brown, the thorax being darker.

Legs pale brown. Hind tarsal ratio 11 : 3 : $1\frac{1}{2}$: 1 : 3.

Wings with venation wholly pale in colour (Fig. 21). In the forewings the passage of Sc_2 is very indistinct. Cross-vein from R_1 to Rs is oblique and it may be that this apparent cross-vein is really R_{2+3} which has bent anteriorly and fused with R_1. This would account for Rs appearing unbranched. Apparent Rs does not fork but distally it bends anteriorly. Cross-vein from Rs to M_{1+2} leaves Rs at about its middle. Cross-vein from M to Cu_1 leaves stem of M.

In the hindwings passage of Sc_2 is distinct and slightly further out than cross-vein R_1 to Rs. The latter is again oblique, as in forewings.

Length of body	2 mm.
Length of anterior wings	2·3 mm.
Length of posterior wings	1·9 mm.

Habitat. Hoshiarpur, Punjab; on *Lantana* flowers, 21-xi-18, A. G. R.

Holotype ♀ in British Museum (Natural History).

Coniopteryx exigua, sp. n.

(Figs. 10 and 22.)

Pale brown. Head, appendages, and genitalia darker. White powder covering whole insect.

Head rounded, somewhat compressed dorso-ventrally. Eyes blackish. Antannae fuscous, 25-jointed. Joints mainly sub-spherical except first two joints which are more elongate. Terminal joint sub-conical. Palpi slightly paler than antennae.

Thorax and legs testaceous, with four darker spots latero-dorsally on thorax. Hind tarsal ratio 9 : 2 : $1\frac{1}{2}$: $1\frac{1}{2}$: $2\frac{1}{2}$.

Abdomen yellowish-brown. Male genitalia dark-brown, and as figured (Fig. 10).

Wings (Fig. 22) slightly tinged brownish, venation pale brown. In forewings Sc_2 and cross-vein R_1 to R_{2+3} are almost opposite each other. In hindwings these two veins are in a straight line, *i.e.*, opposite. There appears to be no cross-vein from Rs to M in hindwings.

Length of body	1·8 mm.
Length of anterior wing	1·75 mm.
Length of posterior wing	1·4 mm.

Habitat. Abbottabad, June 1916, Fletcher coll.

Holotype ♂ in British Museum (Natural History).

Paratype ♀. Similar to male holotype, but pigmentation more blackish and intense.

Head light fuscous. Antennae 23-jointed, dark fucsous. Palpi paler.

Abdomen with chitin unpigmented except at apex where paraprocts alone are dark fuscous. These are small and rounded.

Wings with membrane tinged fuscous. Sc_2 and cross-vein R_1 to R_{2+3} almost opposite in all four wings.

Habitat. On *Bael* leaves, Pusa, 23-xi-1914, Ram Saran.

Coniopteryx ambigua, sp. n.

(Fig. 23.)

Pale brown; antennae dark brown; a brown spot on each shoulder; wing membrane smoky. Entirely covered with white waxy powder.

Head pale, with eyes blackish. Antennae dark fuscous, 24-jointed, the two basal joints swollen and the terminal joint somewhat pyriform. Palpi dark fuscous, terminal joint of each pair hatchet-shaped.

Thorax fuscous, as also legs. A darker brown spot on each shoulder of mesothorax, less distinct on metathorax. Hind tarsal ratio 8 : 2 : 1 : $1\frac{1}{2}$: 2.

Wing membrane somewhat smoky, veins mostly well-marked and fuscous. In forewings (Fig. 23) passage of Sc_2 and cross-vein from R_1 to R_{2+3} almost opposite each other. These two veins are indistinct. R_{2+3} bends somewhat anteriorly towards Sc_2 at its distal extremity.

In hindwings (Fig. 23) Sc_2 and cross-vein from R_1 to R_{2+3} are again almost opposite each other. Cross-vein from Rs to M absent, although there is some indication of this cross-vein in the right wing only. (In one paratype there is a cross-vein from R_{3+4} to M in the right hindwing.) Marginal setae are small in both pairs of wings, but they are more distinct in hindwings and especially along the inner margin of hindwings.

Length of body	1·6 mm.
Length of anterior wings	1·8 mm.
Length of posterior wings	1·5 mm.

Habitat. Kateri Road, Nilgiris, 23-viii-22, P. V. Isaac.

Holotype ♀ in British Museum (Natural History).

Paratypes. (1) ♀. Antennae 24-jointed. Hind tarsal ratio 9 : $1\frac{1}{2}$: 1 : $1\frac{1}{2}$: 2. Cross-vein R_{3+4} to M present in right hindwing only.

Habitat. 2,300 feet. Dehra Dun, on *Lantana* flowers, 27-xi-18, A. G. R.

(2) ♀. Antennae 24-jointed. No cross-vein from Rs to M in either hindwing.

Habitat. Khasis; 5,000 feet. Shillong. October 1916, Fletcher coll.

Coniopteryx obtusa, sp. n.

(Figs. 11 and 24.)

General colour dark fuscous, but the covering of white powder gives a greyish hue.

Head fuscous, with eyes black. Palpi fuscous. Antennae missing.

Thorax dark fuscous, as also legs. Femur of foreleg with a row of six strong setae basad and a few others, smaller and less strong, more distally. Hind tarsal ratio 14 : 5 : 3 : $1\frac{1}{2}$: 4.

Abdomen greyish. Genitalia dark fuscous and of characteristic form (Fig. 11). The two paraprocts (?) are pointed and lie dorsally.

Wings (Fig. 24) with a fuscous tinge, much rounded apically. Sc_2 further out on wing than cross vein R_1 to R_{2+3} in all wings. No cross vein from Rs to M apparent in hindwings. Marginal setae of wings inconspicuous.

Length of body	1·5 mm.
Length of anterior wing	2 mm.
Length of posterior wing	1·7 mm.

Habitat. Pusa, Bihar, 4-iv-08, C. S. Misra.

Holotype ♂ in British Museum (Natural History).

Coniopteryx pusana, sp. n.

(Figs. 12 and 25.)

Pale brown, with head and its appendages, thorax, legs and genitalia darker. Body and wings covered with white waxy powder.

Head rounded, eyes blackish. Antennae long (almost as long as hindwing) dark brown, 32-jointed. (The right antenna is 30-jointed, but is abnormally formed.) Palpi, with terminal joint especially, dark brown. Maxillary palpi with terminal joint elongate and flattened, somewhat trowel-like, about four times the length of penultimate joint. Labial palpi with last joint broad and more or less hatchet-shaped.

Thorax with legs fuscous. Hind tarsal ratio 10 : $2\frac{1}{2}$: $1\frac{1}{2}$: $1\frac{1}{2}$: 2.

Genitalia as figured (Fig. 12) in colour dark brown.

Wing membrane smoky, veins fuscous (Fig. 25). In forewing Sc_2 leaves Sc a little further out on wing than cross-vein R_1 to R_{2+3}. Hindwings rather narrow. Sc_2 leaves Sc well before apex of wing. Cross-vein R_1 to R_{2+3} slightly basad to passage of Sc_2 from Sc to R_1. No cross-vein from Rs to M.

Length of body	2 mm.
Length of forewing	2·2 mm.
Length of hindwing	1·8 mm.

Habitat. On sugar cane, Pusa, 2-ii-21, S. C. Sarkar.

Holotype ♂ in British Museum (Natural History).

Paratypes. There are nine paratypes, three ♂♂ and six ♀♀. Venationally these are all similar, except for very slight differences. Thus in forewings "cross-vein" Sc_2 and R_1 to R_{2+3} may come almost opposite each other. The number of antennal joints in the males varies from thirty-one to thirty-three and in the

females from twenty-nine to thirty-one. In all specimens the cross-vein M to Cu[1] is absent in the hindwings. The shape of the hindwing is quite characteristic.

(1) ♂ Antennae 31-jointed. Wings typical. On sugar cane, Pusa, 1-ii-1921, S. C. Sarkar.

(2) ♂ Antennae 33-jointed. Wings typical. On sugarcane, Pusa, 2-ii-1921, S. C. Sarkar.

(3) ♂ Antennae 33-jointed. Wings typical. On sugarcane, Pusa, 3-ii-1921, S. C. Sarkar.

(4) ♂ Antennae 31-jointed. Wings typical. On sugarcane, Pusa, 3-ii-1921, S. C. Sarkar.

(5) ♂ Antennae 30-jointed. Wings typical. On sugarcane, Pusa, 1-ii-1921, S. C. Sarkar.

(6) ♂ Antennae 31-jointed. Wings typical. On sugarcane, Pusa, 2-ii-1921, S. C. Sarkar.

(7) ♂ Antennae 30-jointed. Wings typical. On sugarcane, Pusa, 2-iii-1921, S. C. Sarkar.

(8) ♂ Antennae 30-jointed. Wings, one pair, typical, others missing. Pusa Bihar, 4-iv-08, C. S. Misra.

(9) ♂ Antennae 30-jointed. Wings typical. Pusa, Bihar, 17-i-13. C. S. Misra.

Coniopteryx cerata, Hagen.

(Fig. 13.)

Hagen[1] described this species from Ceylon in 1858, his original description being as follows :—

" Fusca, albo-pruinosa ; antennis corporis longitudine, articulis duobus basalibus crassis, longis, cylindricis, ceteris moniliformibus : alis aequalibus, sectore primo simplici, secundo bifurcato ; pedibus pallidis.

Long. c. alis 3 mill. ; Exp. alar. 5 mill."

This description is too general to fix the identity of Hagen's species, in the present, more advanced state of our knowledge, but Enderlein[2] has given an amplified redescription of a female which he considers to be conspecific with Hagen's. Enderlein gives the following description :—

" Hell braun, Beine sehr blass, Kopf und Antennen dunkel braun. Hinterleib weisslich, Spitze bräunlich, Antennen 26 gliedrig, kräftig und von etwa halben Vorderflügellänge ; trotzdem das vorliegende Exemplar ein ♀ ist, sind die 5 ersten Geisselglieder sehr kurz, teilweise viel kürzer als dick, und tragen ausserdem an der Innenseite einige ähnliche Schüppchen, wie sie bei den ♂♂ der Gattung *Coniop-*

[1] Hagen, 1858. *Coniopteryx cerata* sp. n. *Verh. zool.-bot. Ges. Wien*, VIII, p. 484.

[2] Enderlein, 1906. Monographie der Coniopterygiden, *Zool. Jahrb.*, XXIII, Abt. f. Syst., pp. 173—242.

teryx an allen Geisselgliedern vorhanden sind. Flügelmembran farblos, Adern sehr blass bräunlich. Im Vorder-und Hinterflügeltrifft die Querader zwischen Subcosta und R_1 genau auf die Querader zwischen R_1 und R_{2+3}. R_{2+} neigt sichim Vorderflügel vor der Mündung in die Flügelspitze ziemlich stark R^1 zu, so dass die Aderenden einander ziemlich stark genähert erscheinen. Mediangabelzelle ziemlich breit; ihr Stiel trägt basalwärts der Querader ein feines Härchen. Flügelrand ziemlich spärlich und mässig lang pubesciert; Cu_2, An und Ax im Vorderflügel mässig dicht pubesciert. Zwischen M und Cu im Hinterflügel keine Querader. Bestäubung des Korpers und Flügel weiss. Verhältnis der Hintertarsenglieder 10 : 2 : 2 : 2 : 3.

Vorderflugellänge	2·6 mm.
Flügelspannung	6 mm.
Fühlerlänge	1·3 mm.

In my own collection there is a male which probably belongs to the same species. Below are given certain characters in which this male specimen differs from Enderlein's description of the female. I do not consider these differences to be of specific rank. As the male genitalia of *Coniopteryx cerata* have not been figured I show these now (Fig. 13).

Description of Male.

Antennae 1·2 mm. long. Left antenna 27-jointed, right antenna 26-jointed. The antennal joints are ringed with modified hairs as usual in males of *Coniopteryx*. Hind tarsal ratio $7\frac{1}{2}$: $2\frac{1}{2}$: 2 : 2 : $2\frac{1}{2}$. Genitalia as shewn (Fig. 13). Wing venation differing only in minor details from that figured by Enderlein.

Length of body	2 mm.
Length of anterior wing	2 mm.
Length of posterior wing	1·7 mm

Habitat. Nuwara Eliya, Ceylon, May 1912.

Bred from cocoon by Mr. E. E. Green.

The cocoon is a beautiful object, of white silk, circular in outline and about 2·5 mm. in diameter. It is fluted radially on its upper surface. Mr. Green notes that it was found on a leaf of *Loranthus* associated with *Aleurodes sp.*

Semidalis fletcheri, sp. n.

(Figs. 14 and 26.)

Brownish, covered with white powdery secretion.

Head missing. Thorax wholly dark brown. Abdomen somewhat paler except apex with genitalia which are dark brown. Genitalia very characteristic, differing considerably from other species of *Semidalis* (Fig. 14). Lateral valves placed more dorsally than usual and not so well differentiated off from the rest of segment wall. Penis sclerites almost straight, scarcely curved upwards at their apices.

Legs uniformly brown in colour. Hind tarsal ratio 11 : 3 : 3 : $3\frac{1}{2}$: $4\frac{1}{2}$.

Wings fuscous, venation well-marked (Fig. 26). Cross vein R_1 to Rs strikes Rs before its fork point in all four wings. Cu_2 and 1st A hardly visible in a space near margin of hindwing.

Length of body (without head)	1·5 mm.
Length of anterior wing	2·6 mm.
Length of posterior wing	2·2 mm.

Habitat. Nilgiris, 6,800 feet; Coonoor; 28 February 1920, Fletcher coll.

Holotype ♂ in British Museum (Natural History).

Semidalis alpina, sp. n.

(Figs. 15 and 27.)

Similar to *Semidalis aleurodiformis*, Stephens. Body and wings fuscous, but completely covered by white powder and thus appearing greyish-white.

Head paler. Eyes rounded, black. Antennae moniliform, dark fuscous, 30-jointed. Palpi dark fuscous.

Thorax and genital segment fuscous, rest of abdomen paler. Genitalia similar to those of *S. aleurodiformis*, Steph., but differing slightly in having more slender and more strongly curved middle processes upon the penunci. (Fig. 15). Legs pale, but with tarsi darker. Hind tarsal ratio 13 : 3 : 3 : $2\frac{1}{2}$: 4.

Wings with veins fuscous and membrane tinged fuscous. The venation (Fig. 27) is similar to that of *Semidalis aleurodiformis*, Steph., var. *curtisiana*, End. Cross-vein from R_1 to Rs strikes the latter before the fork point in all four wings. Marginal setae minute.

Length of body	2·3 mm.
Length of anterior wing	3 mm.
Length of posterior wing	2·4 mm.

Habitat. Kashmir, 8,500 feet; Gulmarg; 17-24 July 1923, Fletcher coll.

Holotype ♂ in British Museum (Natural History).

This species is very similar to *Semidalis aleurodiformis*, Steph., from which it apparently differs only in its often smaller size and in the male genitalia. The inner, upwardly directed prongs of the penis sclerites are slightly less stout basally in the present species than in true *aleurodiformis*. This small difference may be racial and in giving this form specific rank its close relationship to *aleurodiformis* should not be overlooked. The hind tarsal ratio does not seem to be a good character. It is very variable in this species as also in *aleurodiformis*.

Paratypes.

(1) ♂ Antennae 27-jointed. Cross-vein R_1 to Rs strikes latter before fork point in all four wings. Abbottabad; June 1916, Fletcher coll.

(2) ♂ Antennae 31-jointed. Cross-vein R_1 to Rs strikes latter before fork point in forewings and almost at fork point in hindwings. Simla; 7,000 feet; [illegible] August 1920, Fletcher coll.

(3) ♀ Antennae 29-jointed. Cross-vein R_1 to Rs proximal to fork point of Rs in all four wings. Simla; 4-7-vi-21; Fletcher coll.

(4) ♀ Antennae 29-jointed. Cross-vein R_1 to Rs proximal for fork point of Rs in all four wings. Dehra Dun, 2,300 feet; 27-xi-18; on *Lantana* flowers; A. G. R. coll.

(5) ? sex. Metathorax with hindwings and abdomen missing. Antennae 29-jointed. Cross-vein R_1 to Rs in forewings proximal to fork point of Rs. Kumaon; Ramgarh, 6,000 feet; 21-26-viii-18; Fletcher coll.

(6) ♀ Antennae 30-jointed. Cross-vein R_1 to Rs proximal to fork-point of Rs in all four wings. Kumaon; Ramgarh, 6,000 feet; 21-26-viii-18; Fletcher coll.

(7) ♀ Antennae 30-jointed. Cross-vein R_1 to Rs before fork point in all except left hindwing where it is at fork point. Kashmir, 8,500 feet; Gulmarg; 17-24 July 1923; Fletcher coll.

(8) ♀ Antennae 31-jointed. Cross-vein R_1 to Rs proximal to fork point of Rs in all four wings. Hazara District; Dungagali, 8,000 feet; 21-24-v-1915; Fletcher coll.

(9) ♀ Antennae 31-jointed. Cross-vein R_1 to Rs strikes latter at fork point in all four wings. Kumaon; Ramgarh, 6,000 feet; 21-26-viii-18; Fletcher coll.

Semidalis poincianae, sp. n.

(Figs. 16 and 28.)

Pale in colour. Covered with white powder.

Head slightly darker than rest of body. Eyes black. Antennae 28-jointed, dark brown in colour, but with the first joint paler and of the same colour as the head. The majority of the antennal joints are as broad as their length. Palpi dark brown.

Thorax and abdomen pale fuscous. Genitalia as figured (Fig. 16). Legs pale fuscous. Hind tarsal ratio $8 : 1\frac{1}{2} : 1\frac{1}{4} : 1\frac{1}{4} : 2\frac{1}{2}$.

Wings (Fig. 28) with venation pale and membrane almost colourless. Sc_2 and cross vein from R_1 to Rs are widely apart and the latter cross-vein is placed proximally to the fork point of Rs except in the left hindwing where it strikes Rs at the fork point. Venation otherwise typical of the genus *Semidalis*. Setae at margin of wing very fine.

Lenth of body	1·5 mm.
Length of anterior wing	1·7 mm.
Lenght of posterior wing	1·36 mm.

Habitat. On *Poinciana* leaf; Pusa; Haq coll., C. No. 1395; 8-vi-1916; ex pupâ.

Holotype ♂ in British Museum (Natural History).

Paratypes. Two other specimens of the same species were bred from cocoons found on *Poinciana* leaves. Unfortunately both specimens lack heads.

(1) ♂ Genitalia as in holotype. Cross vein R_1 to Rs at fork point of latter except in left hindwing where it is proximal to fork point. Pusa; 15-vi-1916: ex pupâ; C. No. 1395.

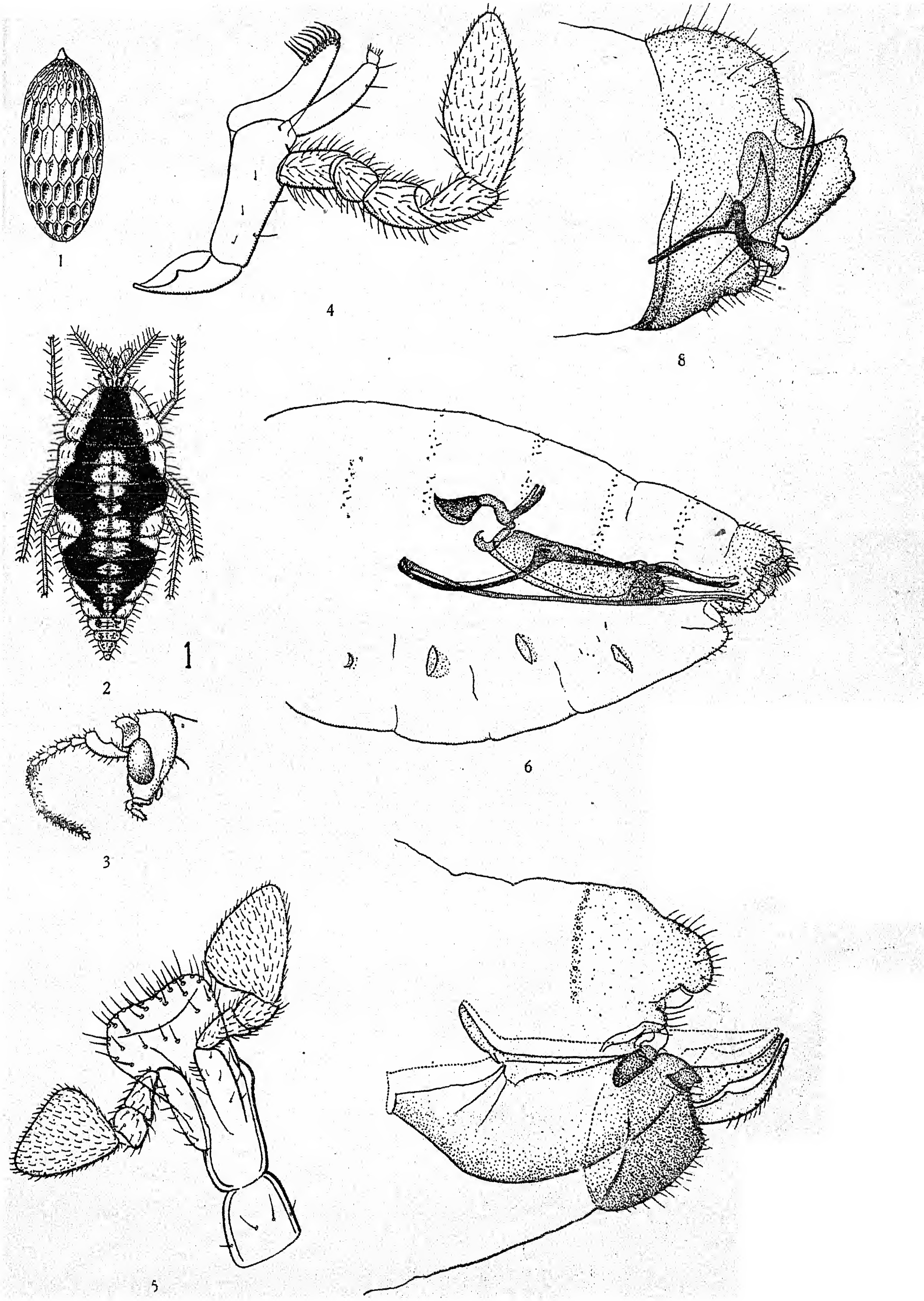
(2) ♀ Paraprocts very broad and *truncate,* not rounded as is more usual. Cross-vein R_1 to Rs proximal to fork point of latter in all four wings Pusa; 8-vi-1916; ex pupâ; Haq coll.; C. No. 1395.

The three cocoons from which the above specimens were bred are of flat ovoid shape and composed of smooth white silk. There is an inner envelope, of about 1·5 mm. diameter, which is completely fused with the outer envelope. The outer envelope is about 3 mm. in diameter. The cocoons have been spun on the upper surfaces of the *Poinciana* leaves. The pupal skin projects from the ruptured cocoon.

This species can easily be recognised in the male by the genitalia and other characters given above. The female may be distinguished by the peculiar shape of the paraprocts.

EXPLANATION OF FIGURES.

1. *Semidalis aleurodiformis* Steph., egg . . . . × 67
2. „ „ „ larva, magnified . . . . ×
3. *Niphadicera terminalis* Bks., (genotype) head from side . . . . × 53
4. „ „ „ „ maxilla . . . . × 214
5. „ „ „ „ labium . . . . × 214
6. „ „ „ „ ♂ abdomen . . . . × 112
7. *Coniocompsa indica* sp. n., holotype ♂, genitalia . . . . × 214
8. *Conwentzia inverta* „ „ ♂ „ . . . . × 214
9. *Nimboa basipunctata* „ „ ♂, „ . . . . × 214
10. *Coniopteryx exigua* „ „ ♂, „ . . . . × 214
11. „ *obtusa* „ „ ♂, „ . . . . × 214
12. „ *pusana* „ „ ♂, „ . . . . × 214
13. „ *cerata* Hagen, ♂ genitalia . . . . × 214
14. *Semidalis fletcheri* sp. n., holotype ♂, genitalia . . . . × 214
15. „ *alpina* sp. n., No. 1, paratype ♂, genitalia . . . . × 214
16. „ *poincianae* sp. n., holotype ♂, genitalia . . . . × 214
17. *Niphadicera terminalis* Bks., genotype, wings . . . . × 30
18. *Coniocompsa indica* sp. n., holotype, wings . . . . × 30
19. *Conwentzia inverta* „ „ „ . . . . × 30
20. *Nimboa basipunctata* „ „ „ . . . . × 30
21. „ *immaculata* „ „ „ . . . . × 30
22. *Coniopteryx exigua* „ „ „ . . . . × 30
23. „ *ambigua* „ „ „ . . . . × 30
24. „ *obtusa* „ „ „ . . . . × 30
25. „ *pusana* „ „ „ . . . . × 30
26. *Semidalis fletcheri* sp. n., holotype, wings . . . . × 30
27. „ *alpina* sp. n., No. 1, paratype, wings . . . . × 30
28. „ *poincianae* sp. n., holotype, wings . . . . × 30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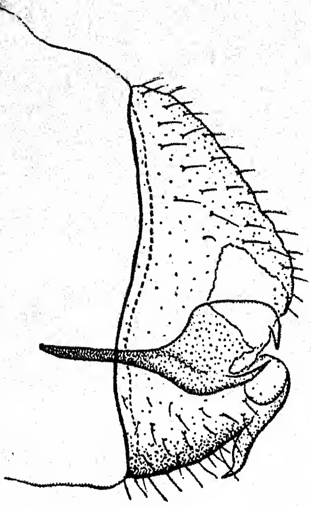

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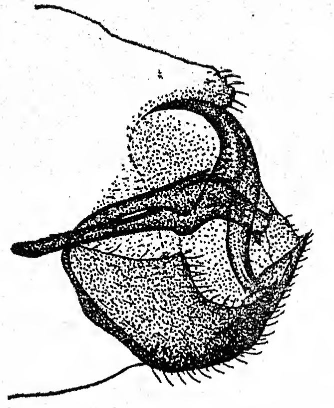

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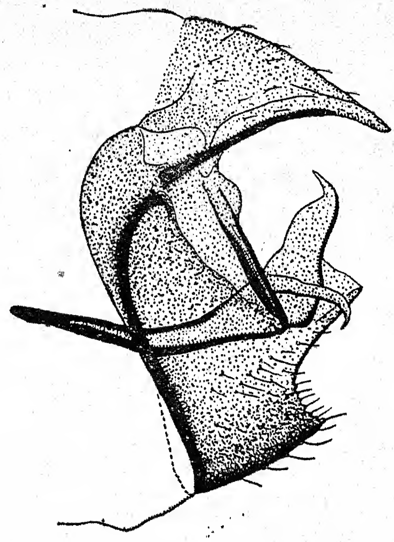

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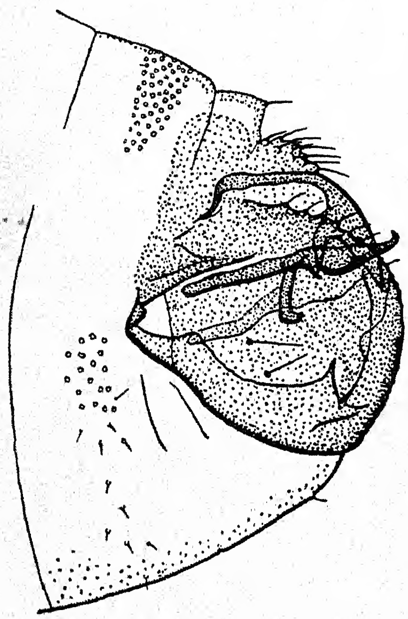

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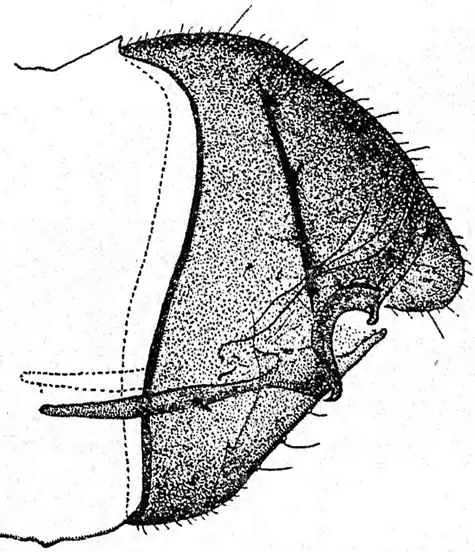

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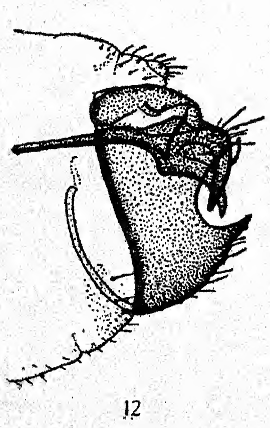

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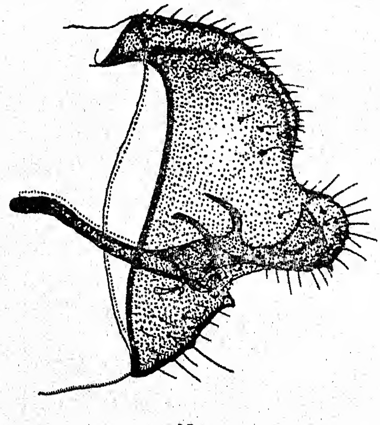

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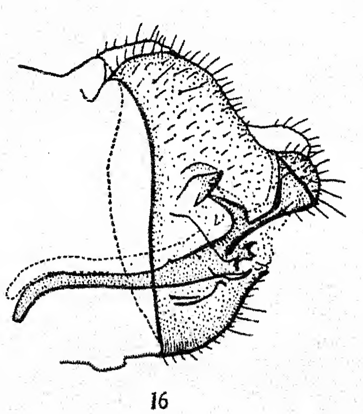

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INDIAN CONIOPTERYGIDÆ.

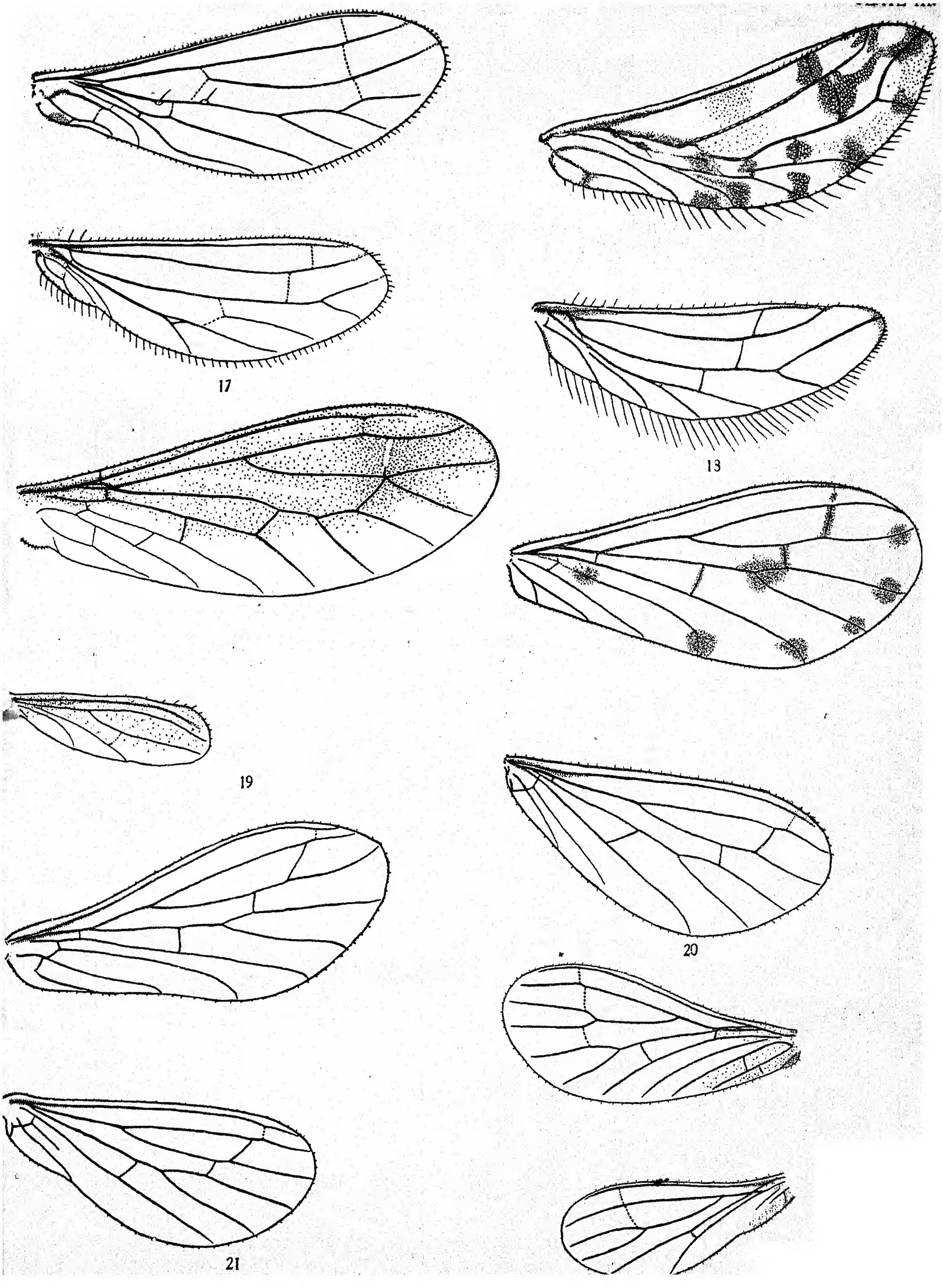

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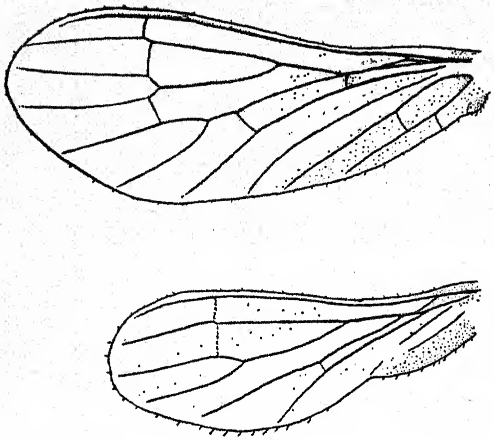
PLATE IV.



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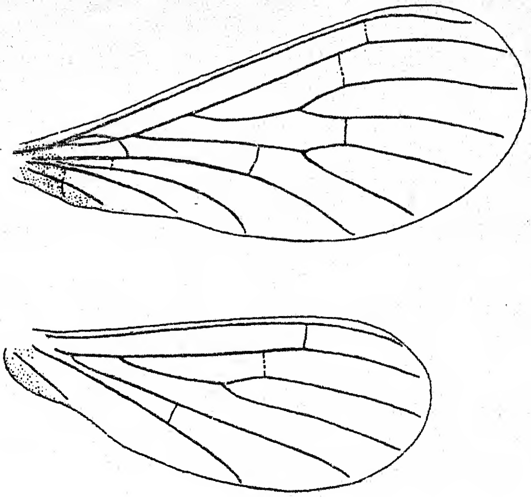

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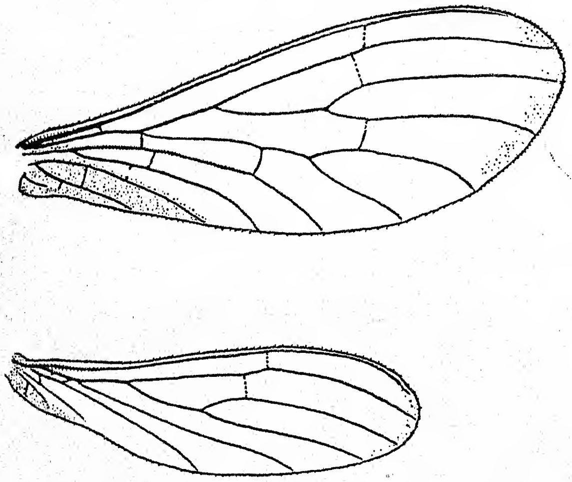

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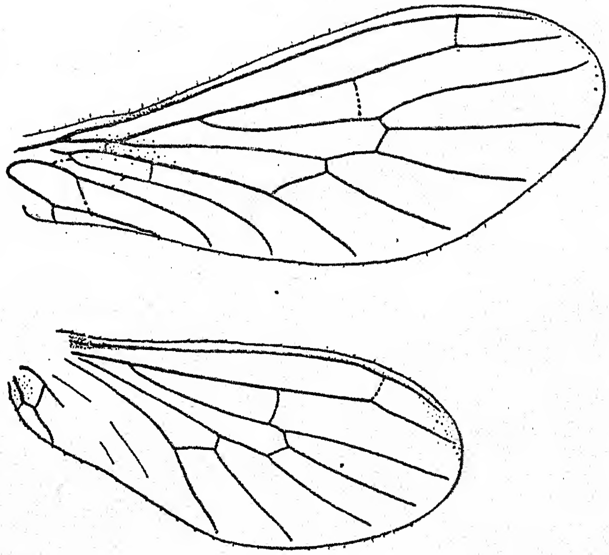

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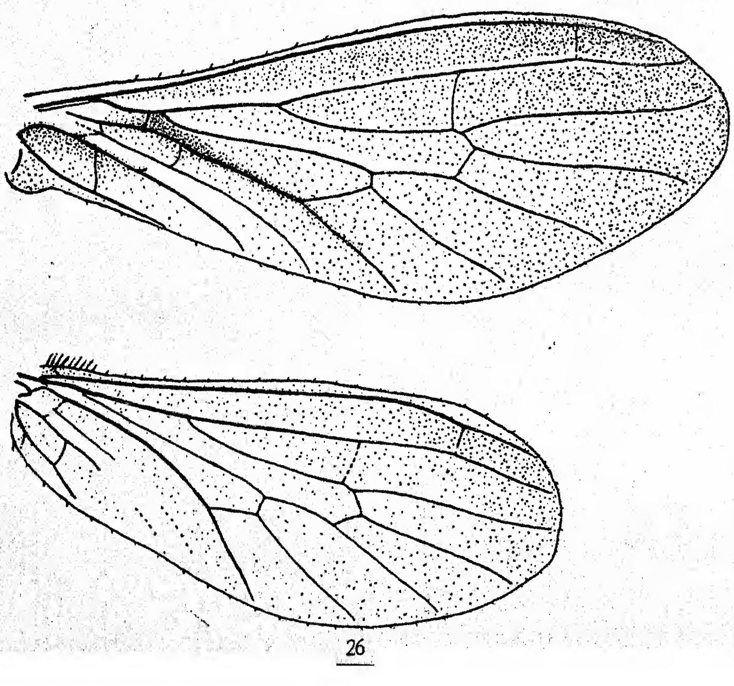

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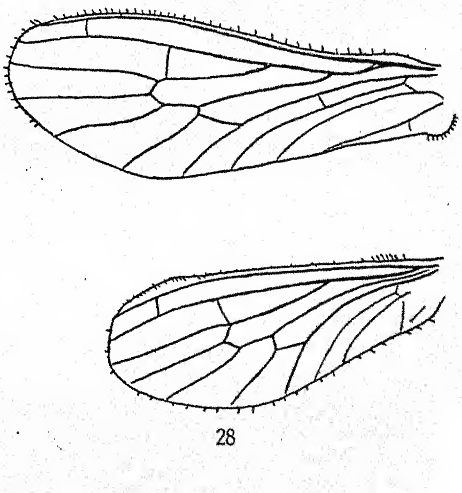

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June 1925 Entomological Series Vol. IX, No. 2.

Memoirs of the Department of Agriculture in India

Papers on Indian Tabanidæ

VIII. The Bionomics and Life-histories of some of the common Tabanidæ of Pusa

BY

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Calcutta: Government of India
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THE BIONOMICS AND LIFE-HISTORIES OF SOME OF THE COMMON TABANIDÆ OF PUSA.

BY

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(Received for publication on 27th January 1925.)

Introduction.

Many of the species of flies of the family Tabanidae found on the Plains of India occur in Pusa (Bihar, North India) and during certain seasons they are fairly abundant. *Tabanus tenens*, Wlk., *T. striatus*, Fabr., *T. rubidus*, Wied., *T. macer*, Bigot (=*bicallosus*, Ric.), *T. nemocallosus*, Ric., *T. virgo*, Wied., and *T. crassus*, Wlk., are plentiful, and of *Gastroxides ater*, Saund, though the imagines are rarely seen, the larvae are easily collected. Some species of *Chrysops* and of *Haematopota* o. exist, but their life-histories have not been studied in full. The life-histories of *T. crassus*, Wlk., and of *T. striatus*, Fabr., were treated by the writer in his earlier papers on Indian Tabanidae.[1]

***Tabanus macer*, Bigot.**

T. macer, Big. (=*bicallosus*, Ric.) is smaller than most other representatives of the genus *Tabanus*. The female sucks blood from cattle and is generally active from mid-day till evening attacking animals standing in the sun and generally prefering the venter of the abdomen to bite.

Life-history.

Egg. Eggs are laid in a mass of about 200 to 300 on low foliage overhanging water (Pl. V, fig. 1). When ovipositing the female sits vertically with its head down. About six eggs are first laid and stuck to the leaf or twig in an almost upright row. More rows are added on row over row. All the rows have nearly equal number of eggs ; only the number of rows may vary in different egg masses which

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[1] The life-history of *T. crassus*, Wlk. *Mem. Dept. Agri., India, Entl. Ser.*, Vol. VIII, No. 5.
Notes on the life-history of *T. striatus*, Fabr. *Mem. Dept. Agri., India, Entl. Ser.*, Vol. VIII, No. 10, vii.

when finished always present a neatly packed appearance. Each egg is about 1·2 mm. long, torpedo shaped and slaty black. The eggs are pearly white when just laid, but they darken on exposure. The incubation period is 4 or 5 days in summer.

Larva. The newly hatched larva is about 1·5 mm. long and whitish. It wriggles out of the egg-shell and drops into the water and within a half hour moults throwing off the body cuticle and the head covering which in the first instar of the larva does not show any oral appendages, but only a dorsal process for breaking the chorion. The second instar larva (Pl. VI, fig. 1a) is quite 2 mm. long, has the normal oral appendages functioning and possesses two pairs of auto-liths at the posterior end. The lateral tracheae are narrow and the larvae are unable to float in water and therefore perish if they cannot creep into wet earth.

The larva lives in the damp earth a few inches above the edge of the water and about 4 inches below the surface and preys on soil organisms and is also cannibalistic. As it grows it becomes brownish in colour the appearance being due to dark cross-bands on the abdomen. It passes through seven instars.

The full grown larva (Pl. VI, fig. 1) is about 20 mm. long, and may appear slightly longer when the head and the anal siphon are fully eversed.

The larval period is about four weeks except in the cold season brood, when due to hibernation it extends to about 16 weeks.

Pupa. The pupa is found in the soil where the larva lived but closer to the surface. It is about 15 mm. long, and brownish (Pl. VII, fig. 1). The abdominal segments have rather prominent rings of spines. The pupal period is about 5 days in summer and about 15 days in the cold season.

Imago. It is easy to distinguish the sexes (Pl. VIII, figs. 1*a*, 1*b*, 1*c*, 1*d* and 1*e*). The female readily sucks blood from cattle and the male in capacity feeds on syrup. Males are rarely seen in nature. When alive the eyes in both sexes are beautiful.

Broods.

There are three broods in the year. Imagines appear and lay eggs first in March and April, then about July and also in October and November.

***Tabanus rubidus*, Wied.**

T. rubidus, Wied. (=*albimedius*, Wlk.) is perhaps the largest Tabanid found on the Indian Plains. The female flies are active when the day is bright and warm and attack cattle for their blood.

Life-history.

Egg. Eggs are laid in large oval masses on twigs and leaves overhanging water—usually there are about 600 eggs in one laying (Pl. V, figs. 2, 2*a* and 3). Each egg is 2 mm. long and cigar shaped and brownish gray. It takes nearly 45 minutes

for a female to lay one mass of eggs, extruding one egg after another and as each is laid shaping the mass with the aid of the terminal plates on the abdomen. The eggs are pearly white when laid but darken in the sun. The eggs hatch in 4 days. Hatching invariably takes place at sun-rise.

Larva. The just hatched larva is about 2·2 mm. long. As soon as it has wriggled out of the egg-shell it drops down into the water and immediately moults. The mouth-appendages appear in the second instar larva (Pl. VI, fig. 2*a*) which is 2·5 mm. long, it is able to float as it has large lateral tracheae. There are two pairs of autoliths in this instar.

These larvae live in the wet soil close to the water edge and sometimes even burrow down below the water level, their tracheal system saving them from drowning. They feed on soil organisms and sometimes attack one another. In confinement they eagerly feed on earth-worms and fly-maggots. They pass through seven instars.

The full-grown larva is about 35 mm. long and whitish in colour (Pl. VI, fig. 2). It is very active. The larval period is about 6 weeks when there is no hibernation.

Pupa. Pupae are found in the soil near the water edge. The pupa is about 25 mm. long (Pl. VII, fig. 2). The pupal period is usually 7 days.

Imago. The sexes may be distinguished by the eyes (Pl. VIII, figs. 2*a*, 2*b*, 2*c*, 2*d* and 2*e*). The males are very seldom seen. The females are easily watched and collected where they frequent for egg-laying. They occasionally lay eggs on plants on the banks of stagnant pools, on foliage several feet above water and rarely even on walls with no water in the vicinity.

Broods.

There are three broods in the year corresponding with those of *T. macer* Big. mentioned earlier.

***Tabanus tenens*, Wlk.**

T. tenens, Wlk. (=*striatus*, auct. *nec* Fabr.) is the most abundant form at Pusa. It is most active at sun-set, just before dusk, when the females come in large numbers to cattle. They prefer the stomach and the lower portion of the legs to bite.

Life-history.

Egg. The eggs are laid in a mass on twigs and leaves just above water along the margin of small streams (Pl. V, fig. 4). There are about 200 to 300 eggs in one mass which when fresh is pearly white in colour, but in a few hours the eggs become dark brown. Each egg is about 1·7 mm. long and cigar shaped. The eggs hatch all together, in the early morning 4 days after they are laid.

Larva. The first instar larva is nearly 2 mm. long and moults as soon as it drops into the water. The second instar larva (Pl. VI, fig. 4*a*) is 2 mm. long and

having large lateral tracheae is able to float. It burrows into the bank and lives at the water-edge. In breeding cages these larvae do well on a diet of fly-maggots. They are cannibalistic.

The larva moults six times before it becomes full-grown and then attains the maximum length of 30 mm. in the seventh instar (Pl. VI, fig. 4). The larval stage occupies about six weeks in summer.

Pupa. The pupa (Pl. VII, fig. 4) is found in the soil where the larval stage was passed but closer to the surface. It is about 20 mm. long. The pupal period is usually 9 or 10 days.

Imago. The eyes in the female are dull, but in the male they are brightly coloured (Pl. VIII, figs. 4*a*, 4*b*, 4*c*, 4*d* and 4*e*). The males occasionally and females often are seen seated on shaded tree trunks or the walls of houses.

Broods.

The usual three annual broods are present in this species also.

***Tabanus virgo*, Wied.**

This is the smallest *Tabanus* found on the Plains. The eggs are said to be laid in small masses on foliage hanging over streams, but no egg masses have been collected at Pusa. Larvae and pupae are however found in numbers in the damp soil on the banks of streams.

Life-history.

Larva. The full grown larva (Pl. VI, fig. 5) is about 16 mm. long and brownish in colour. Its posterior end is rather blunt.

Pupa. The pupa (Pl. VII, fig. 5) is found in the soil as mentioned above. It is about 12 mm. long. The pupal period extends over 6 days.

Imago. The eyes distinguish the sexes (Pl. X, figs. 5*a*, 5*b*, 5*c*, 5*d*, and 5*e*). The females suck blood from cattle. Both sexes were once observed coming in numbers to the lights in a running train.

Broods.

This species has the three annual broods along with that of the other Tabanids treated in this paper.

***Tabanus nemocallosus*, Ricardo.**

The adults of this species are not often seen, but the larvae are very common in the soil along the river bank. The female sucks blood from cattle.

Life-history.

Egg. The eggs are laid in masses (Pl. V, fig. 5) of about 100 to 200 or 300 on leaves and twigs over shallow water along river-banks. Several egg-masses are

often found crowded on the same leaf close to one another and sometimes one mass partly over another. Each egg is 1·2 mm. long, torpedo shaped and slaty black. The egg-masses are elongated and the eggs are a little more slanting than in those of *T. macer*, Big. with which these are easily confused. The outline of the egg-mass is irregularly rounded and thus different from that of the more angular block into which *T. macer*, Bigot, builds its eggs. The egg-period is about 4 days.

Larva. The newly-hatched larva is 1·5 mm. long and moults as soon as it has fallen into the water. The second instar larva (Pl. VI, fig. 6*a*) is 2 mm. long and whitish and has very narrow lateral tracheae and is unable to float. It seems to have only one pair of autoliths at this stage. This and the more marked bunches of spines on the parapodia distinguish these larvae from the same stage larvae of *T. macer*, Big.

The full grown larva (Pl. VI, fig. 6) is 30 mm. long, narrow bodied and yellowish white. The parapodia are very marked. The larvae are found in large numbers in the soil on the river bank about two feet away from the water and 3 or 4 inches below the surface. They seem to have a preference for hard caked up damp earth and they do not attack one another. In captivity the larvae refused to feed on earth worms, maggots or chironomid larvae or culicid larvae. Therefore the length of the larval stage could not be determined.

Pupa. The pupa (Pl. VII, fig. 6) is found close to the surface in the soil along the river bank. It is light brown in colour and about 20 mm. long. The pupal period is 9 or occasionally 10 days.

Imago. The sexes differ in the size and colour of eyes (Pl. X, figs. 6*a*, 6*b*, 6*c*, 6*d* and 6*e*). Gorged females are sometimes caught in bushes waiting to lay eggs.

Broods.

At Pusa this species has three broods concurrent with those of the other common Tabanids.

Gastroxides ater, Saunders.

This belongs to the family Tabanidae. The larvae are found in the muck in holes in tree trunks. The adults are rarely seen. The mouth-parts of the female suggest that they are intended for piercing and sucking.

Life-history.

The eggs or first stage larvae have not been observed. The full grown larva (Pl. VI, fig. 3) is about 24 mm. long and yellowish white with sometimes a tinge of red. It feeds apparently on organisms around it sucking their juices. The larva can remain without food for very long periods.

Pupa. The pupa (Pl. VII, fig. 3) is blackish. It is about 22 mm. long and occurs in the same site as where the larva is found. The pupal stage lasts 6 days.

Imago. The adults (Pl. IX, figs. *3a*, *3b*, *3c*, *3d* and *3e*) have besides the difference in the eyes in the two sexes, in the male a dark brown band across the base of the abdomen at its base.

Broods.

There is only one brood in the year. Imagines emerge in June and July. Hibernation takes place in the larval stage. The larval growth is very slow.

Remarks on the common Tabanidæ of Pusa.

In all observed cases the first instar larva has no mouth-parts, but has a mask-like head covering with a dorsal anterior toothed process for breaking open the egg-shell.

Tabanid larvae in general are able to withstand long periods of fast. Owing to dearth of food, therefore, apart from the regular broods it is possible that imagines emerge at times on irregular occasions.

The pupae of the several species are distinct in general appearance and particularly in the cluster of posterior terminal spines termed together as the pupal aster.

The colour of the eyes of the imagines vary, but in dry specimens they all lose the metallic lustre and other features present in life. In the plates of imagines in this paper the colours are taken from living forms.

EXPLANATION OF PLATES.

PLATE V. *Egg-masses of Tabanidæ.*

1.	Egg-mass of *T. macer*, Bigot	× 4
2.	„ *T. rubidus*, Wied.	× 4
2*a*.	Single egg of „ „	×10
3.	Egg-mass of „ „ (dorsal view)	× 4
4.	„ *T. tenens*, Wlk.	× 4
5.	„ *T. nemocallosus*, Ric.	× 4
6.	„ *T. macer*, Bigot	× 4

PLATE VI. *Larvae of Tabanidæ.*

1.	Larva of *T. macer*, Bigot, Full grown	× 3·5
1*a*.	„ „ „ Second instar	×16
2.	„ *T. rubidus*, Wied., Full grown	× 3
2*a*.	„ „ „ Second instar	× 16
3.	„ *G. ater*, Saund, Full grown	× 3·5
4.	„ *T. tenens*, Wlk., Full grown	× 3·5
4*a*.	„ „ „ Second instar	× 18
5.	„ *T. virgo*, Wied., Full grown	× 3·5
6.	„ *T. nemocallosus*, Ric., Full grown	× 3·5
6*a*.	„ „ „ Second instar	×18

PLATE VII. *Pupae of Tabanidæ.*

Showing features of the pupae of—

1. *T. macer*, Bigot; 2. *T. rubidus*, Wied.; 3. *G. ater*, Saund; 4. *T. tenens*, Wlk.; 5. *T. virgo*, Wied. and 6. *T. nemocallosus*, Ric.

a.	Pupa	× 3
b.	Ventral view of posterior extremity of female pupa	× 9
c.	Ditto ditto male pupa	× 9
d.	Pupal aster	×18

PLATE VIII. *Adult Tabanids.*

1*a*.	*T. macer*, Bigot ♀	× 3·5
1*b*. and 1*c*.	Head of same, front view and lateral view	much enlarged.
1*d*.	*T. macer*, Bigot ♂	× 3·5
1*e*.	Head of same, lateral view	much enlarged.
2*a*.	*T. rubidus*, Wied. ♀	×2
2*b*. and 2*c*.	Head of same, front view and lateral view	much enlarged.
2*d*.	*T. rubidus*, Wied. ♂	× 2
2*e*.	Head of same, lateral view	much enlarged.

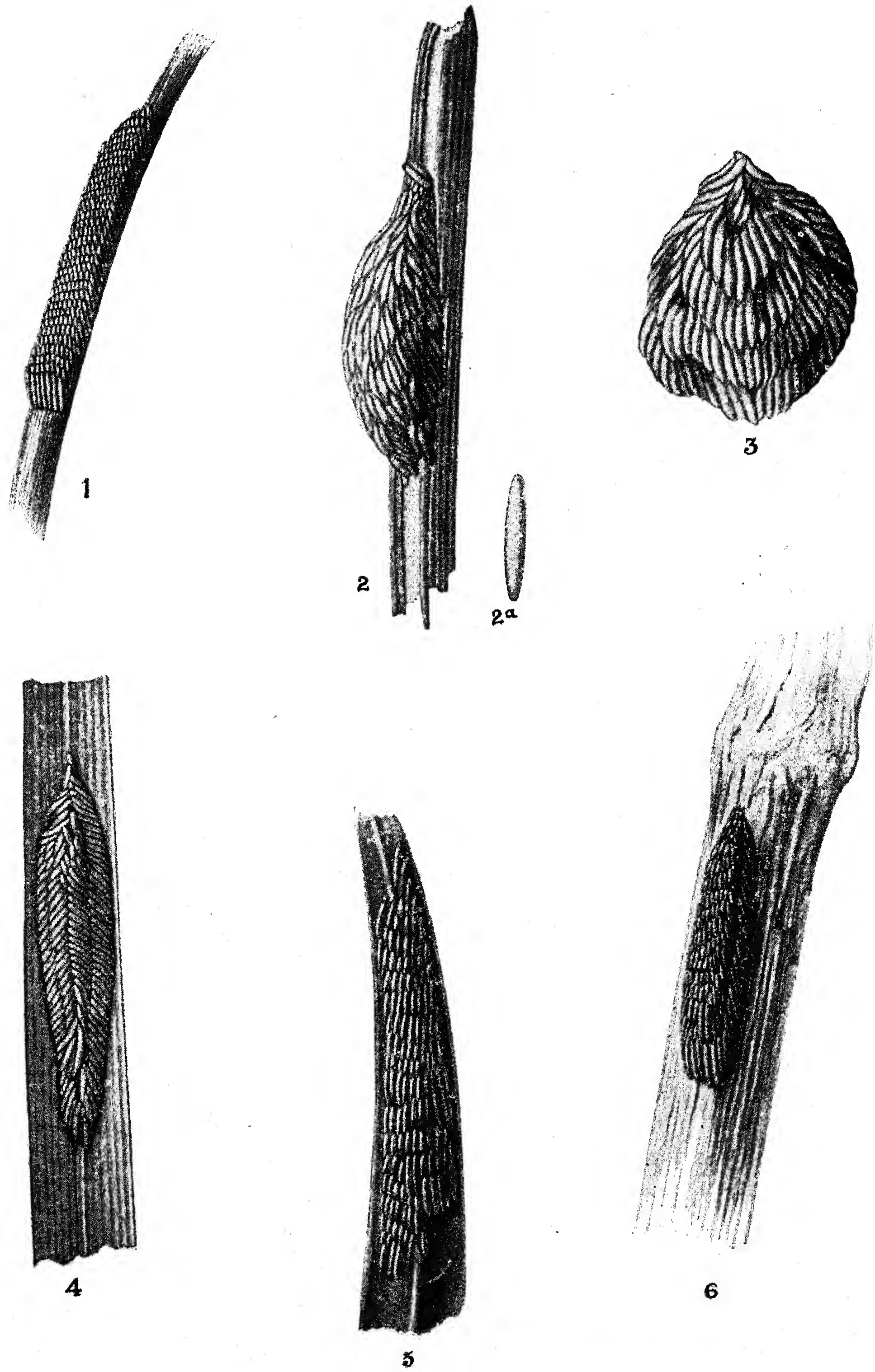
PLATE IX. *Adult Tabanids.*

3*a*. *G. ater*, Saund ♀	× 2
3*b*. and 3*c*. Head of same front view and lateral view	much enlarged.
3*d*. *G. ater*, Saund ♂	× 2
3*e*. Head of same, lateral view	much enlarged.
4*a*. *T. tenens*, Wlk. ♀	× 2
4*b*. and 4*c*. Head of same, front view and lateral view	much enlarged.
4*d*. *T. tenens*, Wlk. ♂	× 2
4*e*. Head of same, lateral view	much enlarged.

PLATE X. *Adult Tabanids.*

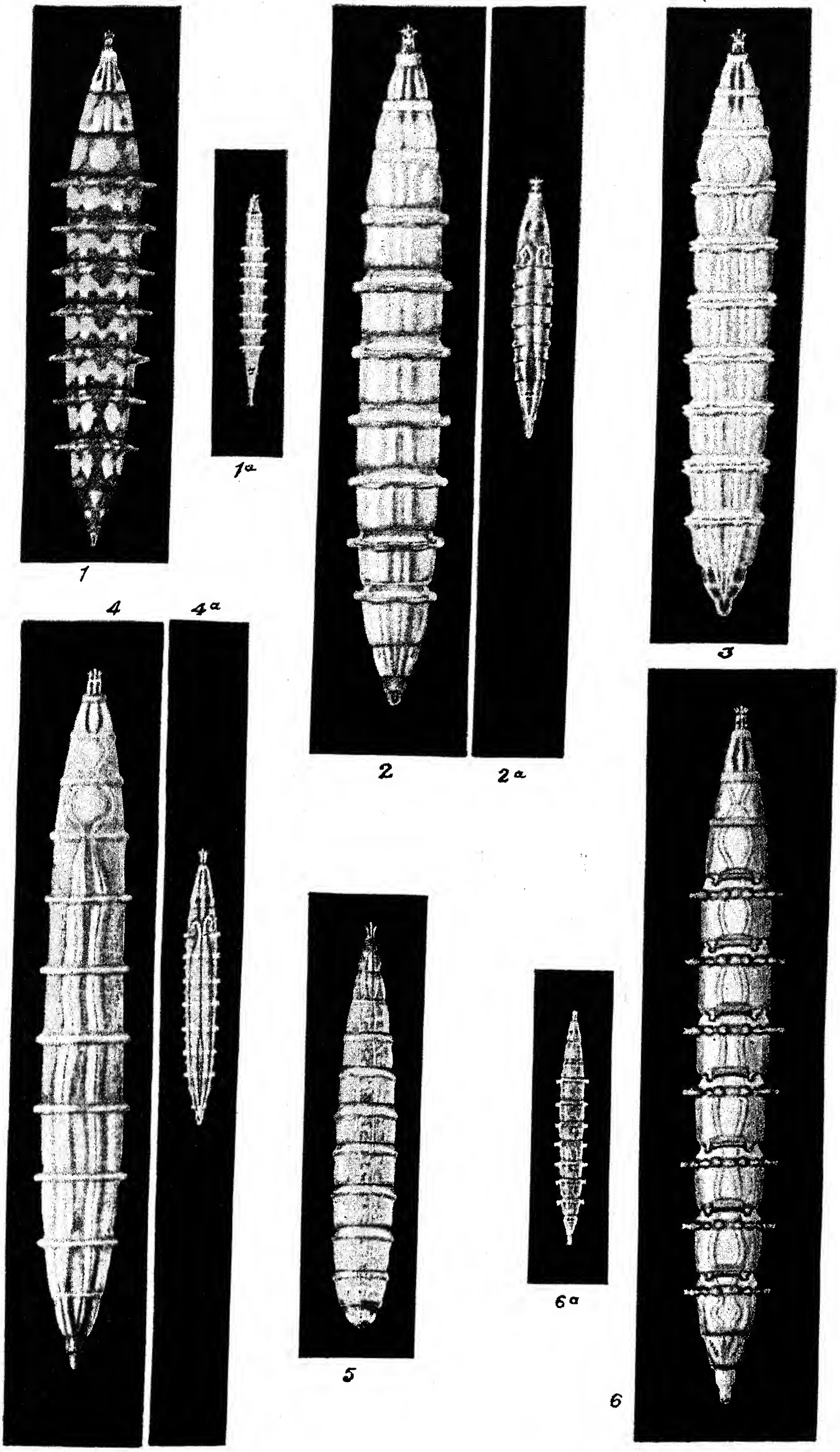
5*a*. *T. virgo*, Wied. ♀	× 4
5*b*. and 5*c*. Head of same, front view and lateral view	much enlarged.
5*d*. *T. virgo*, Wied. ♂	× 4
5*e*. Head of same, lateral view	much enlarged.
6*a*. *T. nemocallosus*, Ric. ♀	× 2·5
6*b*. and 6*c*. Head of same, front view and lateral view	much enlarged.
6*d*. *T. nemocallosus*, Ric. ♂	× 2·5
6*e*. Head of same, lateral view	much enlarged.

PLATE V.

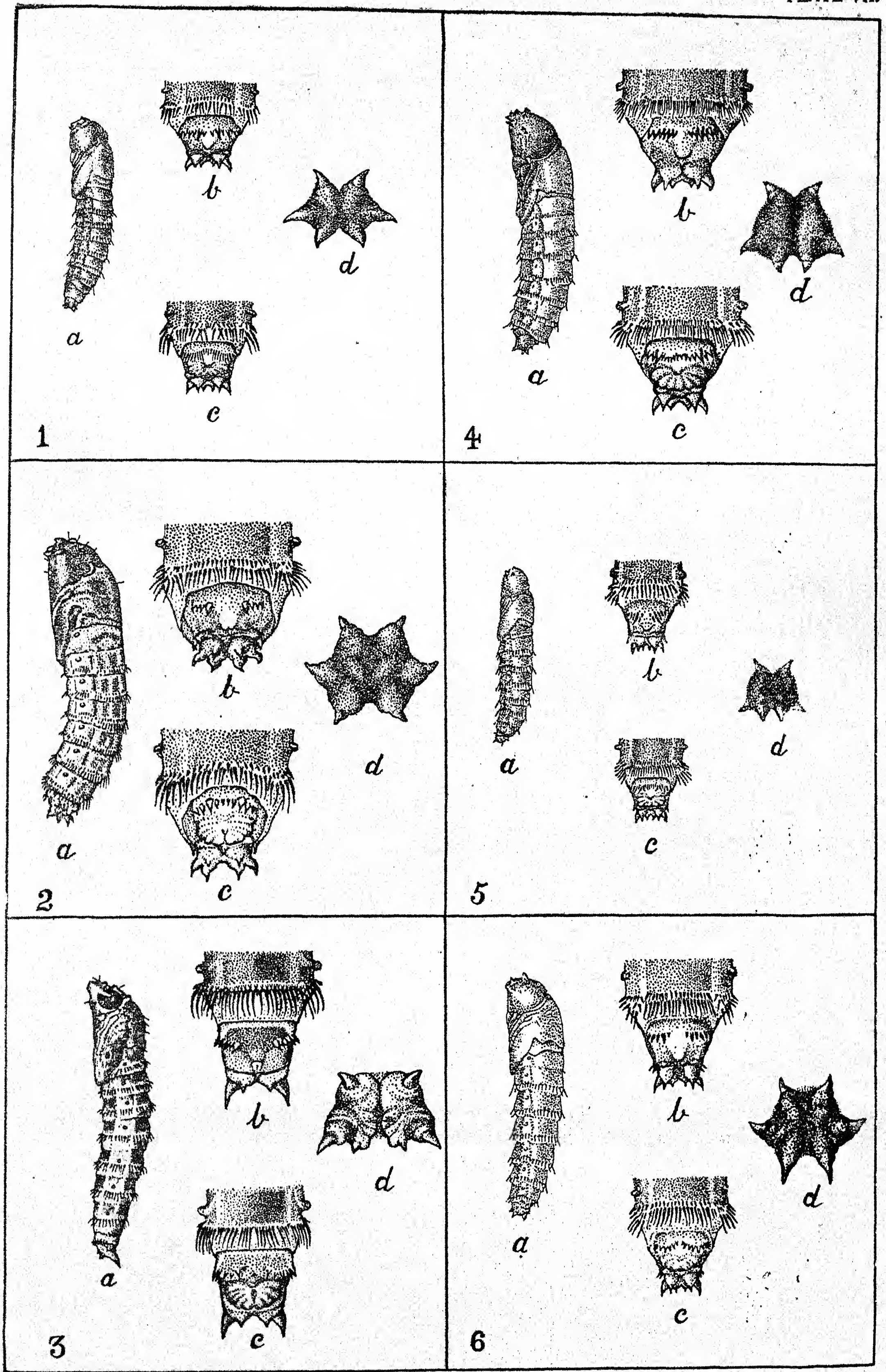


EGG-MASSES OF TABANIDÆ

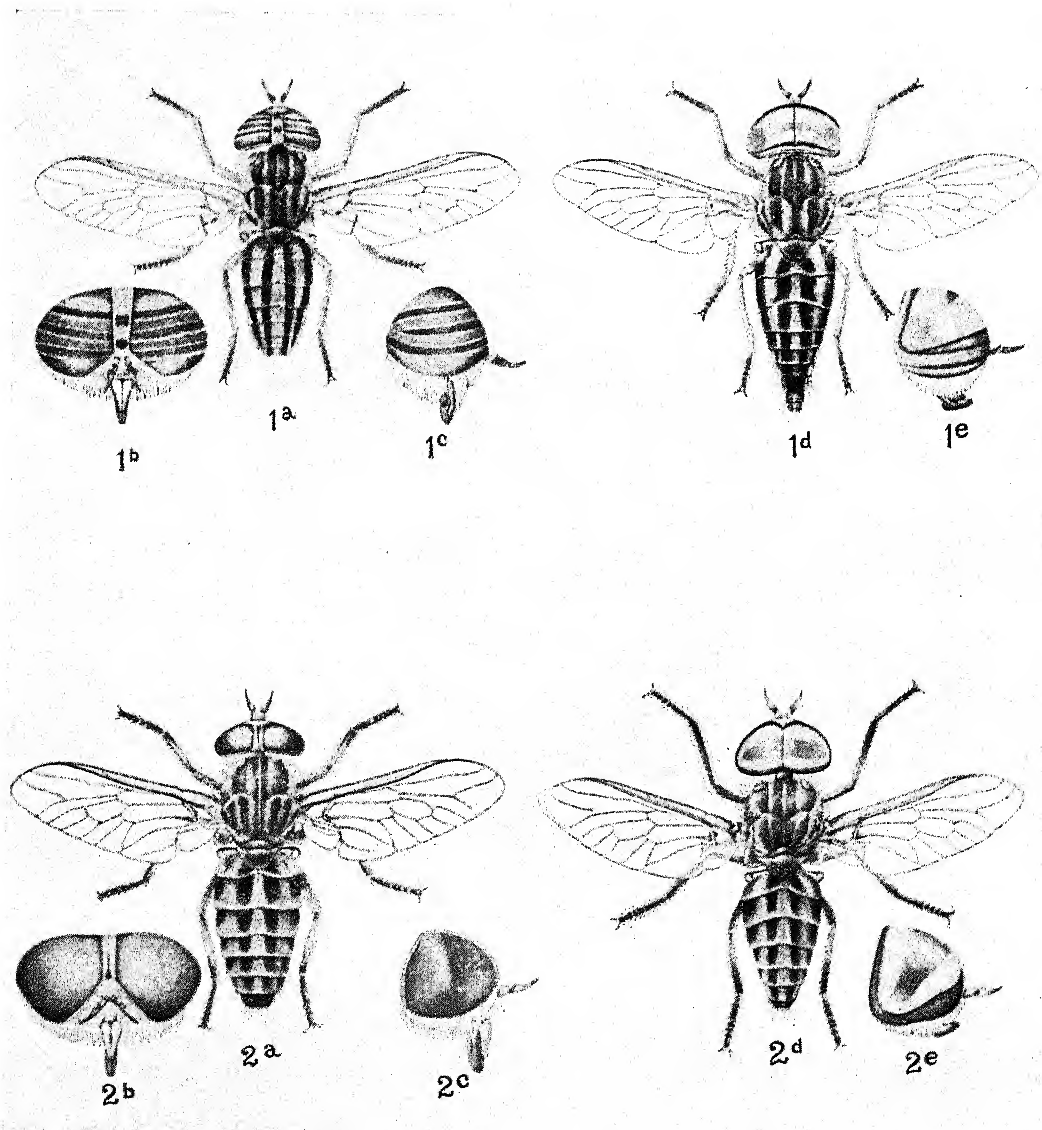
PLATE VI.



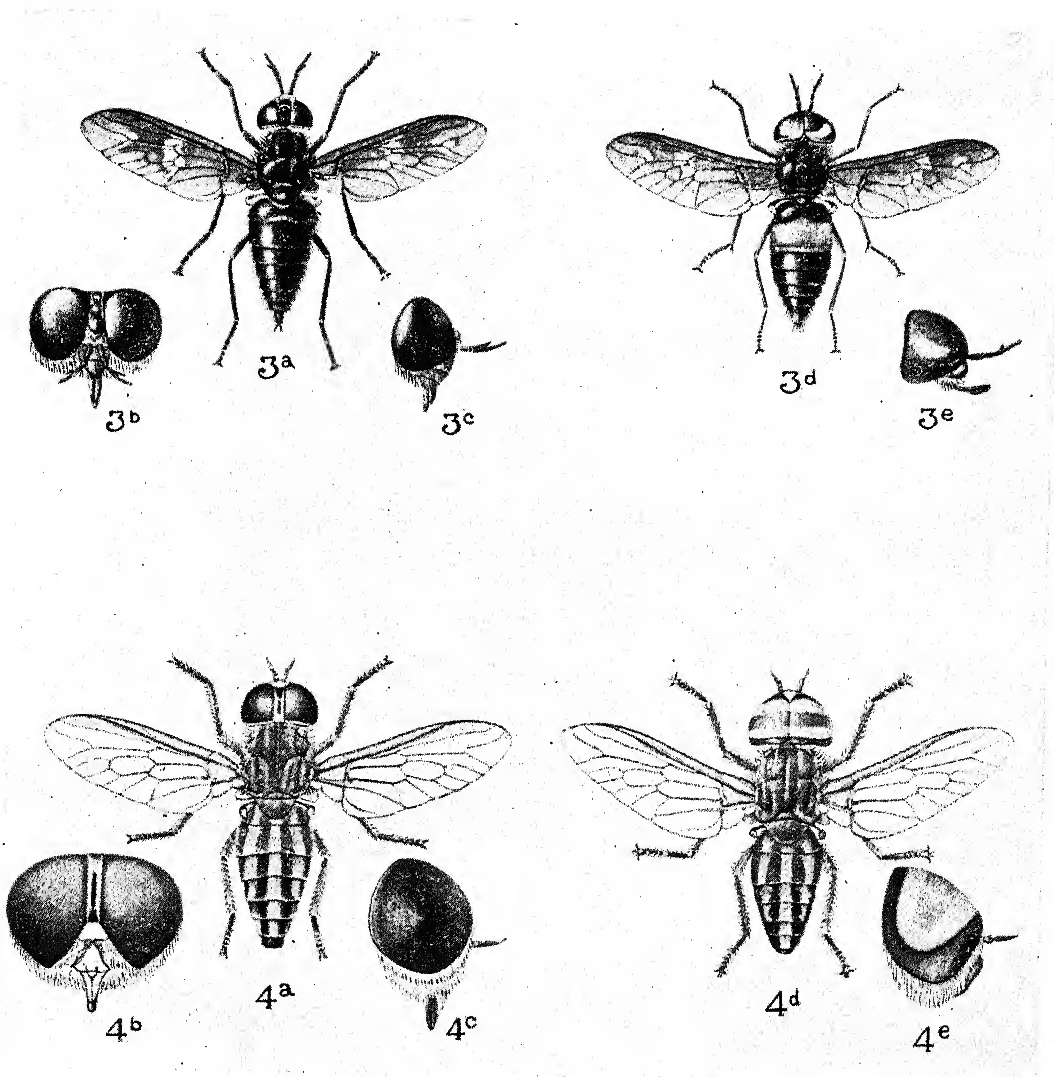
LARVÆ OF TABANIDÆ



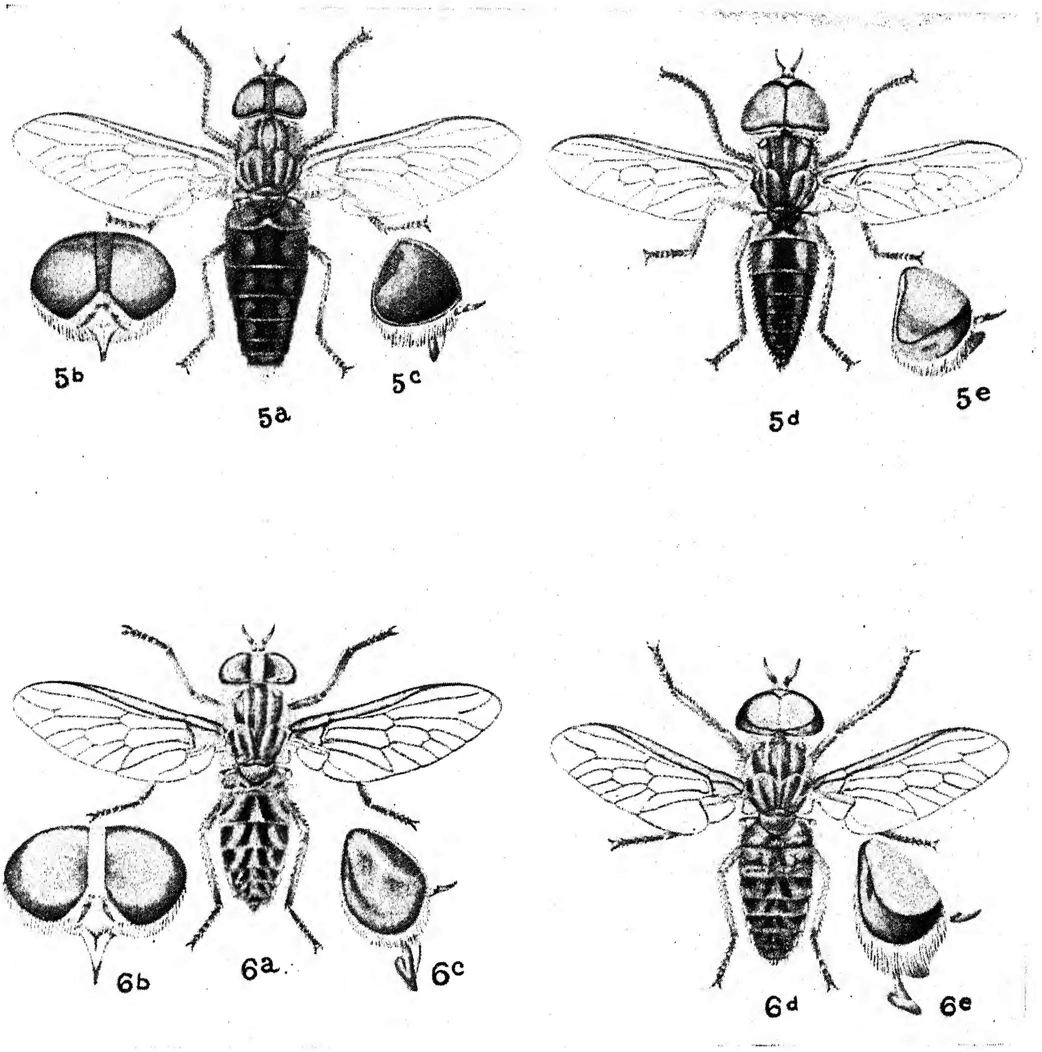
PUPÆ OF TABANIDÆ.



TABANUS MACER, BIGOT AND T. RUBIDUS, WIED.



GASTROXIDES ATER, SAUND. AND T. TENENS, WLK.



TABANUS VIRGO, WIED. AND T. NEMOCALLOSUS, RIC.

June 1925 Entomological Series Vol. IX, No. 3.

Memoirs of the Department of Agriculture in India

Some observations on the Life-history and Habits of Phycus brunneus, Wied. (Family Therevidæ)

BY

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SOME OBSERVATIONS ON THE LIFE-HISTORY AND HABITS OF *PHYCUS BRUNNEUS*, WIED. (FAMILY *THEREVIDÆ*).

BY

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(Received for publication on 27th January 1925.)

Very little is known of the life-history and habits of the flies of the family *Therevidæ*. As the imagines are generally predaceous the family deserves more attention from economic entomologists, while the morphologist may find much that is interesting in the structure of the larva.

According to Williston[1] (1908) the adults prey on other Diptera for which they lie in wait. Lefroy[2] (1909) says that the adults are predators on insects, but there is no information as to the forms they mostly prey on. The young larvae according to Verrall[3] (1909) probably live in loose earth and sand and are ready to prey upon any vegetable or animal refuse or even to affix themselves to living larvae. Malloch[4] (1917) states that the larvae are found in the ground and also in decaying wood and are predaceous feeding on various insect larvae and are apt to be cannibalistic.

Phycus brunneus, Wiedemann.

It is believed that the few observations I have made on the life-history and habits of *P. brunneus*, Wied. will be of interest and will add to our knowledge of the family. The imagines have been found in Pusa (Prov. Bihar, India) during the months of March and April. The egg stage is not known, but the larvae occur among the excreta of bats in crevices and fissures in walls.

The mature larva. (Pl. XI, figs. 1, 2 and 3.) The full grown larva is about 20 mm. long and of a shiny yellowish white colour. It has a snake-like appearance. The larva is eucephalous and amphi-pneustic, is quite smooth and possesses a single

[1] Williston (1908). North American Diptera.
[2] Lefroy (1909). Indian Insect Life.
[3] Verrall (1909). British flies.
[4] Malloch (1917). A preliminary classification of Diptera, exclusive of Pupipara, based upon larval and pupal characters with keys to the imagines of certain families, *Part I, Bull. III, St. Lab. of Nat. Hist., Vol. XII, Art. III.*

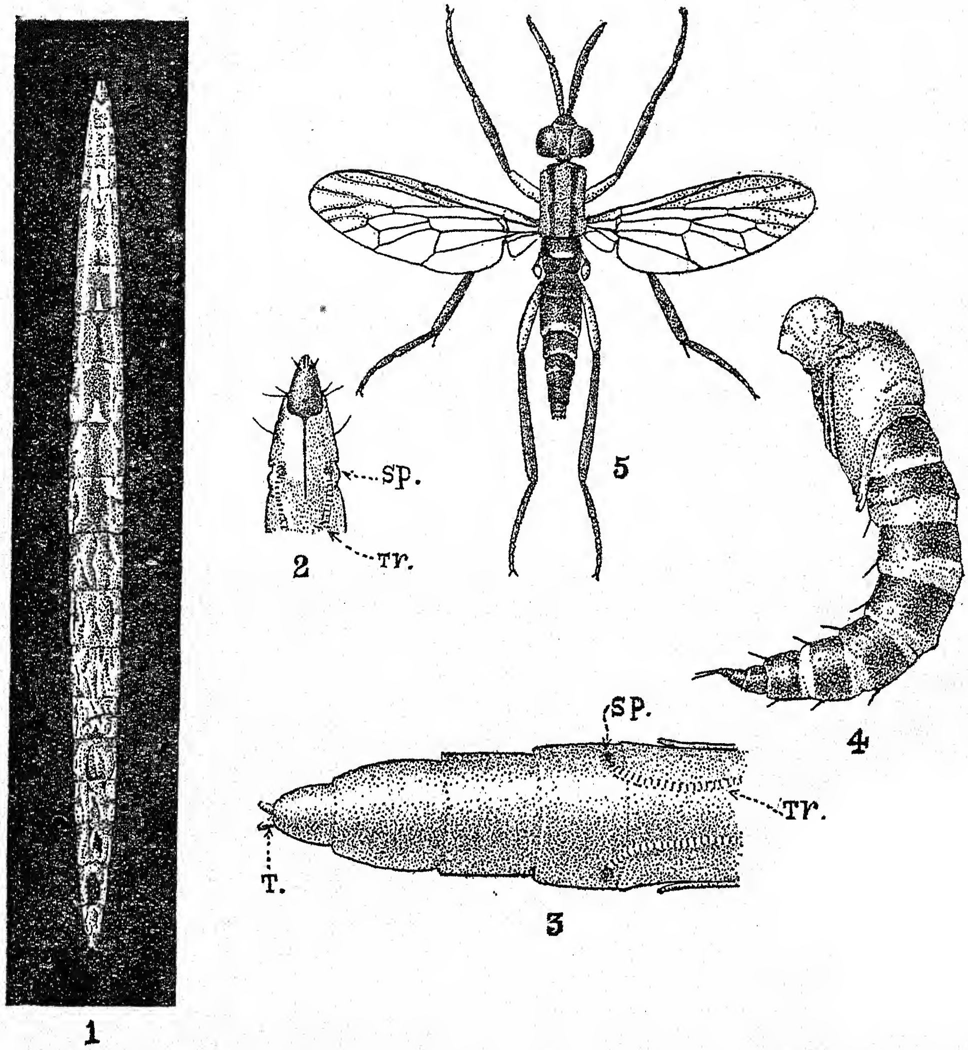
pair of pseudo-pods at the tip of the ultimate segment which is usually folded ventrad. The long snaky body is divided into twenty segments, this appearance being due according to Malloch to the false division into two of each of the first six abdominal segments. The first pair of spiracles are on the first thoracic segment, not on the second segment as stated by Brunetti (1920) and the posterior pair of spiracles are on the fourth segment from the anal end.

The food of the larva. The larva is predaceous and occasionally cannibalistic, wherefore not more than one or two of these larvae are found in the same situation. The organisms preyed on are chiefly Dermestid larvae which are fairly plentiful in bat excreta owing to the presence therein of chitinous insect tissue. The *P. brunneus* Wied. larva sucks its prey and it is not unusual to see the sucked out shrivelled body of a small larva of the species when a number of these are reared together in the same cage.

The Pupa. (Pl. XI, fig. 4.) The pupa is about 12 mm. long, of a brownish colour and with the abdomen curved and always has a quantity of extraneous matter sticking to it evidently for protection as there is no real cocoon. The pupal period seems to extend from seven to twelve days.

The imagines. Both sexes are very much alike, the eyes are dichoptic in both but the male has the abdominal tip turned upward and also has the genital armature fairly visible. The flies are very active and resemble some of the Hymenoptera in their movements specially in the rapid beating movements in the air of the fore-legs. They are predaceous and are sometimes found on glass windows. Once I took one when it had caught and almost overpowered a common house-fly.

PLATE XI.



Phycus brunneus, Wied.

1. Mature larva × 6; 2. Anterior end of larva, much enlarged; sp. spiracle; Tr. trachea; 3. Posterior end of larva, much enlarged; T. terminal pseudopods; other letters as before; 4. Pupa × 6; 5. Imago, Female × 6.

CONTENTS

THE RED PUMPKIN BEETLE, AULACOPHORA ABDOMINALIS FB. (*COLEOPTERA CHRYSOMELIDÆ*) AND ITS CONTROL; WITH A SHORT NOTE ON A. ATRIPENNIS, FB.

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I. INTRODUCTORY.

The most important vegetables cultivated during the summer in the Punjab belong to the Natural Order Cucurbitaceæ ; one need only mention the very familiar gourds (*Lagenaria vulgaris*), pumpkins (*Cucurbita maxima*), *tindas* (*Citrullus vulgaris*, var. *fistulosus*), *ghia-tories* (*Luffa ægyptiaca*), and cucumbers (*Cucumis sativus*). In the vicinity of every town cucurbits are grown over large areas and every village has its plots of these vegetables. Further, melons and water-melons are the favourite fruits and extensive areas are put under these every year. In 1922-23, of the canal-irrigated land, 98,643 acres were under melons alone (18), and there is every year a much larger area of well-irrigated and *barani* (unirrigated) land under melons and water-melons.

The Red Pumpkin Beetle (*Aulacophora abdominalis*, Fb.) has proved a serious menace to the cultivated cucurbits and numerous complaints of extensive damage by the *bhoondi* have been received from practically every part of the Punjab. It is not only the cucurbit vegetables which are attacked but very often extensive fields of melons are entirely devastated. In one particular case a field of 4 acres had no more than 20 melon vines surviving an attack of this pest. The damage caused by the adult insect to the germinating or young crop is often so serious that

Figures within brackets in the text refer to bibliographical numbers at the end.

resowing becomes necessary, and if the sowing season is over the farmer has to face serious losses. Of the pests of vegetables in the Punjab, the Red Pumpkin Beetle is undoubtedly one of the greatest importance. The damage caused by this insect must run to tens of thousands of rupees every year.

Aulacophora abdominalis, Fb. has been known as a pest of cucurbits in India for a very long time. Surgeon-General E. Balfour (7) says : " A red beetle of Northern India is described in Mr. Firmenger's book on gardening as very destructive," and this 'red beetle' was most probably no other than the above mentioned species. Cotes (4, 5, 6) makes a definite mention of it as a pest. Lefroy (14) includes it in his " Indian Insect Pests," and in his " Indian Insect Life " (15, p. 362) he gives the following scanty information about this beetle :— " Though *A. foveicollis*, Kust., is extremely common, nothing is known of its life-history and all attempts to solve the problem hitherto have failed. It is a destructive insect to young cucurbitaceous plants, eating the leaves." Fletcher (7) records this insect as pest of cucurbits from Madras. A coloured plate of the various stages of this insect with a very brief account of its life-history, habits and control measures appeared in 1917 and according to Fletcher (8) 'it took five years to discover the mode of life of the early stages of this common insect '.

Such being the state of our knowledge of this very common pest of the Cucurbitaceæ all over India, a thorough study of this insect was regarded essential.

Casual observations on the life-history and habits were made during the last few years, but the problem was definitely taken in hand during May 1923 and observations were continued till May 1925. The results presented in this paper have thus been obtained after full two years' work.

The investigations were carried out at the Punjab Agricultural College, Lyallpur, and have been supplemented by information received from some other localities in the Punjab and facts ascertained at Pusa during the senior author's stay there. The work was carried out by the junior author under the guidance of the senior author and the former is mainly responsible for the data presented.

II. GENERAL.

It is interesting to note that of the Chrysomelid pests of cucurbits the most important belong to the two genera of the sub-family Galerucini. While *Diabrotica* spp. (particularly *D. vittata*, Fab.) are pests of cultivated cucurbitaceæ in America and some other parts of the New World (3), *Aulacophora* spp. devastate the plants of this natural order in the Old World. These two genera closely resemble in their structure, life-history and habits and yield to the same control measures.

The species of *Aulacophora* Chevr. which have been reported as pests during the last 12 years have been tabulated below. A perusal of this table will show

that most of the species mentioned are pre-eminently pests of the Cucurbitaceæ :—

Name	Food-plant	Locality	Reference to R.A.E.A. except those in figures.
Aulacophora sp.	Snake gourd	Ceylon	II, XII
A. abdominalis, Fb.	Young cucurbits	Mesopotamia, India	VIII (7, 8, 9)
A. atripennis, Fb.	Cucurbits and *patal*	South India, Bengal	(7, 8, 9)
A. cartereti, Guérin	Cucurbits	Queensland	II
A. coffeæ, Hornst.	Seed heads of lettuce Cucurbits.	Philippines Do	I V
A. fabricii	New Guinea Bean	Fiji	X
A. fabricii	Squash and pumpkins	Samoa	XII
A. femoralis, Mots.	Vegetables	Japan	I
A. hilaris, Boisd.	Cucurbits "now attacks peaches, nectarines, cherries, apples." Cucurbits	Queensland New South Wales Australia	VIII V IV
A. olivieri, Guérin.	Cucurbitaceæ, maize (leaves and silk).	Queensland, N. S. Wales.	II, VIII, VII
A. orientalis, Hornst.	*Melothria orgyea* and allied plants.	East Africa	XI
A. palmerstoni, Blackb.	Cucurbits	Australia	IV
A. similis, Oliv.	Mulberry (minor pest)	Formosa	VI
A. stevensi, Baly.	Cucurbits	South India, Ceylon, Burma.	(7, 8, 9)
A. wilsoni, Baly.	Cucurbits	Queensland	II

Attention is drawn to the fact that there exists considerable confusion regarding the species of *Aulacophora* and Junk in his recent Catalogue sinks into synonomy this generic name.

Only three species of *Aulacophora*,* Chevr. have so far been recorded from India as pests of cucurbitaceous plants. These species can be easily distinguished by their colouration, particularly that of the elytra :—

A. abdominalis, Fb. General colour orange-red dorsally, with orange-red elytra; ventral surface of abdomen generally black.

*No work has so far been done on this genus and most probably many species occur in India.

A. atripennis, Fb. Head, prothorax and scutellum orange, elytra black; ventral surface orange.

A. stevensi, Baly. General colour same as in *A. abdominalis*, but with a well marked black stripe along the outer margin of the elytra, elytral suture black; ventral surface yellow.

Of the three species only the first two occur in Northern India and *A. abdominalis* is by far the commoner and consequently of greater importance. It is this species which is dealt with in the following pages.

III. *AULACOPHORA ABDOMINALIS*, FB.

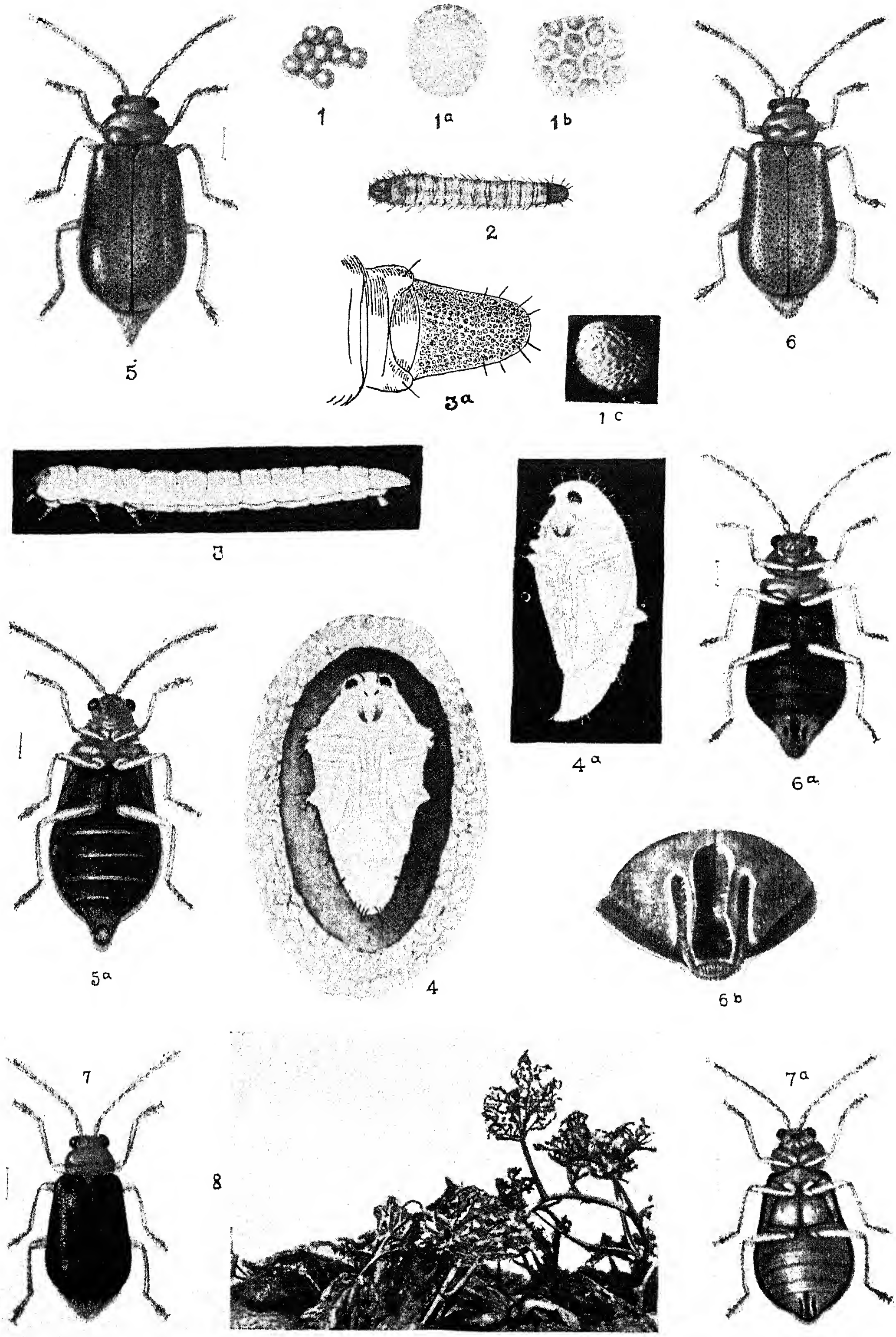
1. Distribution.

A. abdominalis, Fb. has a very wide range of distribution, and has been recorded from localities mentioned in the following table:—

Locality	Food-plant	References
Europe—		
Shores of the Mediterranean Sea	....	(4)
Africa—		
Shores of the Mediterranean Sea .	....	(4)
Sudan	Melons	(11)
Asia—		
Mesopotamia	Young cucurbits . . .	R.A.E.(A.) VIII
India—		
Assam, Burma . . .	All cucurbits	(9, 10)
Bengal, Hooghly, Dacca .	Paddy (*Oryza sativa* [?]), Cucurbits	(4, 5, 6)
Bihar and Orissa . . .	Cucurbits	(9, 10)
Central Provinces . . .	Ditto	(9, 10)
Gwalior	Ditto	(9, 10)
Madras (throughout S. India up to 4,000 ft.).	Ditto	(7)
United Provinces, Saharanpur .	Water caltrop (*Trapa bispinosa*)	(4, 5, 6) [see page 45]
Punjab (up to 6,000 ft. Kasauli)	Cucurbits	(2, 9, 10)
North-West Frontier Province .	Ditto	(9, 10)
Andamans	Ditto	
Ceylon	Melon and other cucurbits .	R.A.E.(A.) II, XI
Australia—		
Queensland	Ditto . .	(13)
Northern territory	Ditto . .	(13)
North Western Australia . .	Ditto . .	(13)
Aru	Ditto . .	(13)

In the Punjab this beetle is of common occurrence wherever cucurbits are grown, and every farmer and vegetable grower is familiar with the '*lal-bhoondi*' the 'red-beetle.'

PLATE XII.



Explanation of Plate XII.

Aulacophora abdominalis, Fb.

1, Egg cluster enlarged.
1*a*, An egg much enlarged.
1*b*, Portion of egg further enlarged to show honey-comb sculpture on egg shell.
1*c*, Photograph of an egg enlarged.
2, Newly hatched larva.
3, Full grown larva.
3*a*, Anal shield dorsal view.
4, Pupa in pupal chamber.
4*a*, Pupa.
5, Female dorsal view.
5*a*, Female ventral view.
6, Male dorsal view.
6*a*, Male ventral view.
6*b*, Last visible sternum of male.

Aulacophora atripennis, Fb.

7, Male dorsal view.
7*a*, Male ventral view.
8, Damaged plants.

2. Description of various stages.

(1) Egg. (Pl. XII, figs. 1-1c). The eggs when laid singly are irregularly spherical, each measuring 0·612 mm. in diameter (average of 24 measurements) ; when laid in groups they are pressed against each other and become more or less polyhedral in outline. They are usually laid in a single layer in small batches, but sometimes a few may be laid over the first layer ; there is, however, no well defined arrangement. The freshly laid eggs are yellow in colour but turn orange after a short time. The egg-shell is sculptured with well marked ridges which meet each other, forming an irregular honey-comb-like structure (16). In a freshly laid egg the shell is soft and elastic, but turns hard and brittle on exposure to air.

(2) Larva. (Pl. XII, figs. 2, 3, 3a). A newly hatched larva is slender in form and of uniform thickness ; it is about 1·2 mm. long and about 0·28 mm. across the body ; the head is brownish in colour, and measures 0·3 mm. in length and 0·283 mm. across ; the antennæ are three-jointed. Prothorax is brownish dorsally and light-yellow ventrally and laterally. The rest of the body is creamy yellow in colour. The body is smooth except for the few long setæ that are present on the head and rest of the body. The last segment possesses a dark coloured anal shield marked with characteristic pittings and set with four pairs of long setæ. On the ventral side of this segment is a median, cylindrical process called " prop-leg " which is used by the larva in walking. Thoracic legs are light yellow in colour, and bear small hairs ; tarsi are unsegmented and each tarsus bears a single claw. A full grown larva measures about 12 mm. in length and 1·6 mm. across the body. The head is nearly as broad as long and is pale brown in colour ; the body is creamy white except the anal shield which is slightly darker.

(3) Pupa. (Pl. XII, figs. 4, 4a). The pupa is 6·5 to 7·5 mm. long and about 3·5 mm. across the mesothorax. The dorsum is convex and the pupa is slightly curved so that the head is pressed against the prosternum. Pronotum is rather large and broad and covers the head so that the latter becomes almost invisible from above. The antennæ lie curved up under the folded legs. The thoracic legs lie folded under the abdominal segments ; the third pair is covered over by the wings which are also folded under the abdominal region. Small brown setæ arising from tubercles are clearly visible.

Changes in the colour of the pupa. The eyes acquire blue-black colour and become prominent within 5-12 hours ; a yellowish tinge appears on the dorsal side of the head and thorax on the third or fourth day after pupation ; the colour of the elytra, changes at first into brownish black and then becomes slaty.

In the pupal chamber the pupa appears as if standing on its hinder end, and when disturbed, it jerks its body and spins rapidly round its axis in a characteristic manner.

(4) Adult. (Pl. XII, figs. 5, 5a, 6, 6a, 6b.) The adult is an elongate oblong beetle. The female (5·5-8·8 mm. in length and 2·3 to 3·5 mm. in breadth) is larger than the male, (5·5-8 mm. in length and 2·3 to 3·4 mm. in breadth). Its

general colour is brilliant orange-red, antennæ and legs are light orange and pygidium has the same colour as the elytra, metasternum and the ventral surface of the abdomen entirely black and clothed with silvery pubescence.

Head. Average length of head is 1·4 mm. and breadth 1·2 mm., surface smooth' vertex brilliant with reddish yellow colour ; clypeus yellow and somewhat convex, covered with brownish hairs all over ; antennæ light orange, eleven-jointed, basal joint being the largest and thickest particularly in male ; all joints pilose, the basal joint having the least number of hairs : compound eyes prominent, bulging and coal-black.

Thorax. The pronotum, nearly twice as broad as long, brilliant light orange in colour ; a transverse sulcus undulating in the middle runs across it, the lateral edges and part of the pronotum thickened and raised up, surface covered with minute punctures. Scutellum prominent, smooth and of brilliant orange-red colour. The elytra orange-red in female and light orange in the male, fine and close punctures present on the surface of the elytra.

Abdomen. Five abdominal segments distinctly visible ; the tergum of the last visible segment a triangular plate pointed in the female and obtuse in the male, the posterior margin of the last visible sternum notched in the female, and divided into three parts in the male, the middle portion being rectangular and having a longitudinal wide groove on it. The last abdominal sternum coloured black to nearly one-third of its anterior portion.

3. Life-history.

Beetles in copulation were brought from the fields and caged in deep glass dishes. About an inch of soil was placed at the bottom of each dish. The beetles fed and oviposited readily. It was found that for oviposition and successful rearing the soil in the dishes must be kept moist. The newly hatched grubs were provided with pieces of tender shoots, stems and roots of their food plants. They also fed quite readily on leaves and seemed to prefer those which were in course of decay. In most of the experiments, however, the decaying food was removed and grubs were fed on fresh material.

The beetles that had emerged in the laboratory were paired ; they copulated quite readily in captivity, and oviposited. Thus complete life-history was followed in many cases. As long as there was sufficient moisture in the cages the development went on successfully.

(1) Copulation. The duration of copulation, in captivity, was found to vary from 5 to 75 hours. The same pairs were noticed to copulate several times, the females laying a batch of eggs after each copulation. It was also noticed that one male was capable of copulating with a number of females at different times.

(2) Oviposition. Eggs were mostly laid during the night, and very few eggs were seen laid during day time. The females started oviposition a day or two after copulation but this varied with different individuals and in some cases eggs were

not laid till the seventh day after copulation. Oviposition is not continuous and generally there is an interval of two or three days between each laying.

Eggs may be laid singly or in batches. In the glass dishes, in the laboratory, they were laid on the surface of the moist soil or just below it, and occasionally on the leaves supplied as food. In the fields they were found laid on the surface of moist soil round the base of the food plants, in cracks or under small heaps of pellets of moist earth, but always in shady places.

The maximum number of eggs laid by a single female, in captivity, was 295 and the maximum number laid at one laying was 60. There are 24 to 30 egg-tubes in each ovary and it seems likely that at each laying not more than one egg is deposited from each egg-tubule. Examination of the ovaries also showed that only one egg developed at a time in each ovarian tubule. As the female lives over a month and egg laying continues all through, it is probable that a very large number of eggs is laid. From 29 to 240 eggs were found laid round one plant, and as there are possibilities of all hatching out, the losses caused by grubs must be considerable.

In the table below are given details about the oviposition of a few females :—

Statement of oviposition records of A. abdominalis, Fb. *in the Laboratory at Lyallpur during 1923 and 1924.*

Cage slip No.	Dates of Oviposition	No. of eggs laid	Total	REMARKS
1923-5-13	22-5-23	25	125	Died on 28-5-23.
	25-5-23	50		
	26-5-23	50		
1923-7-11	24-7-23	60	176	Died on 3-8-23.
	26-7-23	60		
	1-8-23	6		
	3-8-23	50		
1923-7-31	7-8-23	60	84	Escaped on 13-8-23.
	10-8-23	10		
	11-8-23	2		
	12-8-23	12		
1924-3-21 b	23-3-24	52	152	Died on 11-4-24.
	25-3-24	36		
	28-3-24	19		
	31-3-24	27		
	2-4-24	18		
1924-3-23 b	25-3-24	20	106	Died on 21-4-24.
	4-4-24	17		
	6-4-24	23		
	14-4-24	39		
	20-4-24	7		
1924-3-23 b	25-3-24	8	199	Died on 4-5-24.
	28-3-24	18		
	1-4-24	6		
	4-4-24	21		

Statement of Oviposition records of A. abdominals, Fb. *in the Laboratory at Lyallpur during 1923 and 1924*—contd.

Cage slip No.	Date of Oviposition	No. of eggs laid	Total	REMARKS
1924-3-23 c	9-4-24	25	199	Died on 4-5-24.
	13-4-24	24		
	16-4-24	20		
	20-4-24	37		
	23-4-24	10		
	25-4-24	30		
1924-3-21	28-3-24	17	80	Died on 5-5-24.
	31-3-24	21		
	4-4-24	7		
	6-4-24	3		
	11-4-24	5		
	13-4 24	20		
	14-4-24	7		
1924-3-21 c	28-3-24	43	99	Escaped on 10-4-24.
	1-3-24	33		
	5-4-24	3		
	6-4-24	5		
	7-4-24	9		
	8-4-24	2		
	9-4-24	4		
1924-3-23 a	28-3-24	35	149	Died on 25-4-24.
	3-4-24	22		
	9-4-24	24		
	13-4-24	22		
	16-4-24	33		
	20-4-24	13		
1924-3-19	1-4-24	17	64	Died on 21-4-24.
	2-4-24	3		
	16-4-24	17		
	18-4-24	17		
	21-4-24	10		
1924-3-23 e	4-4-24	22	167	Died on 15-5-24.
	13-4-24	14		
	16-4-24	13		
	20-4-24	22		
	25-4-24	10		
	29-4-24	17		
	1-5-24	4		
	4-5-24	26		
	11-5-24	39		
1924-10-28	31-10-24	10	295	This female was kept in the laboratory in a warm place and so continued laying, and did not enter into hibernation.
	1-11-24	16		
	3-11-24	50		
	5-11-24	50		
	8-11-24	58		
	13-11-24	46		
	20-11-24	32		
	7-12-24	5		Died on 8-12-24.
	8-12-24	28		

Factors influencing oviposition. In all experiments on oviposition it was noticed that eggs were readily laid on the surface of moist soil and whenever the soil was allowed to become dry oviposition stopped. Fertilized females kept in cages with dry soil rarely oviposited and eggs in such cases were laid invariably on green leaves supplied as food.

In April 1924 one gourd plant was covered over with a cage in the field and was not watered, so that the soil all round it was dry. Two pairs of beetles in copulation were introduced, the bettles lived for 15 days but not a single egg was laid. Two more pairs were introduced and these also laid no eggs.

Under natural conditions it was noticed that eggs were laid in large numbers just after the fields had been watered. This was particularly the case during May, June and July when in the Punjab the soil dries up rapidly. It was also observed that the fields which were regularly irrigated and kept well supplied with water had plenty of eggs laid on the moist soil, while the fields which were kept more or less dry had very few eggs. Eggs were sometimes laid in the glass tube in which beetles had been collected and in which humidity was very high.

The above facts clearly prove that a certain amount of moisture is essential for oviposition.

(3) HATCHING. The eggs hatch out in about 6 to 15 days, duration of the egg stage depending mainly on temperature and humidity. A few hours before hatching the egg acquires a deep orange tinge and a shining appearance. The movements of the grub can be seen through the transparent shell. The grub cuts an irregular hole on one side and pushes its head out, and then by a violent jerking movement works its body free.

The eggs laid on the leaves in cages did not hatch out in any case, the leaves decayed and became mouldy and the eggs were also attacked by the mould. If the soil became dry after the eggs had been deposited such eggs did not hatch. This shows that a certain amount of moisture is necessary for proper development of the embryo. The excess of moisture, however, lowered the percentage of hatching and prolonged the egg stage. The following experiments performed during April 1924 throw light on the problem. In all cases the eggs were laid on moist soil in the glass dishes used for rearing :—

No.	Treatment	No. of eggs treated	No. of eggs hatched	Per cent. of hatching
1	Soil kept moist, eggs kept in shade . . .	183	183	100
2	Soil kept moist, eggs exposed to sun for 4 hours .	54	28	50
3	Eggs kept under water for two days, kept in shade	59	26	43
4	Eggs kept under water for two days and dried in sun	101	8	8
5	Eggs kept under water for two days and exposed to sun for 4 hours.	99	0	0
6	Soil kept dry after oviposition	92	5	5·4
7	Ditto ditto	221	0	0
8	Soil kept dry and eggs exposed to the sun for 4 hours	121	0	0
9	Eggs treated with a weak crude oil emulsion .	63	22	33

From the above it will appear that the most favourable conditions for hatching are moisture and shade. Exposure to the sun is harmful and so is prolonged submergence under water. In laboratory when the eggs were laid on moist soil in glass dishes and a proper degree of moisture was maintained the proportion of the eggs hatching was 73·6 per cent. (out of 691 eggs 509 hatched successfully).

(4) LARVA. The newly hatched grub is quite active and moves about rapidly. It begins to feed upon roots and stems and bores into these. Later in the season the fruit is attacked, the larva boring into the fruit from the side lying on the ground. The larvæ cut holes in the leaves which lie on the soil and feed concealed under them. At the end of every instar the grubs enter the soil to moult and come out again to feed. Under favourable conditions and adequate food supply a grub becomes full grown and enters the prepupal stage within a fortnight after hatching, but the grub stage might last as long as 23 days. In fields the grubs are found in large numbers under surface of the soil round the roots of the cucurbitaceous plants, as also boring into roots, stems and fruits.

As the grubs enter the soil for moulting it is difficult to find out the number of instars. The measurement of the head was resorted to and grubs which were kept in glass dishes and supplied with pieces of gourd for food were taken out every day and measured. The width of the head was found to be :—

0·28 mm. for the first days.
0·40 mm. for the next 5 days.
0·58 mm. for the next 3 days.
0·63 mm. for the last 3 days.

Thus there are 4 larval instars. The duration of each instar varies with the food supply, temperature, etc., and the figures given above represent the time taken during March and April.

(5) PUPA. The larva when full grown leaves the surface and tunnels into the soil, where it prepares an oval chamber by moving its body round its longitudinal axis. The pupal chamber is quite smooth and appears to be lined with some secretion which makes it waterproof. It was noticed that even if water was kept standing for hours in a dish containing a pupal chamber, under only an inch of soil, the water could not enter the chamber. Even when feeding inside the fruit the larvæ leave it and enter the soil to pupate. Although hundreds of larvæ of various sizes were found inside the fruits no pupa was ever discovered.

The grub lies motionless in the pupal chamber, decreases in length and increases in thickness, and within 2 to 5 days it moults and changes into pupa.

In fields the pupæ were found in large numbers round the roots of the food plants. They were found to occur at any depth varying from $\frac{1}{3}''$ to $10''$. The pupal stage lasts from 7 to 17 days after which the adult emerges out.

To get some idea of the population of larvæ and pupæ one cubic foot of soil was removed from round the roots of each of the attacked creepers and on an average 50 pupæ and larvæ ready to pupate were found in it.

(6) ADULT. The adult beetle as it emerges is pale in colour but it soon develops its proper tinge. Soon after its emergence it begins to feed. Mating usually takes place at this stage and egg-laying commences in about a week's time.

(7) DURATION OF LIFE-CYCLE. The complete life-cycle—from the time the egg is deposited to the time the adult emerges—occupies from 32 to 55 days. The details of the various stages may be summarised as below. :—

1. Egg stage . . . . 6 to 15 days.
2. Larval stage . . . . 13 to 23 days.
3. Pupa stage . . . . 7 to 17 days.
4. Adult stage . . . . The adults live for over a month, except during hibernation when they live for more than 5 or 6 months.

Statement showing the duration of various stages of Aulacophora abdominalis.

Serial No.	Date of oviposition	Date of hatching	Egg stage (days)	Date of pupation	Larval stage (days)	Date of emergence	Pupal stage (days)	Total duration of life cycle	No. and sex of beetle emerged
1	25-5-23	1-6-23	7	19-6-23	18	27-6-23	8	33	1♂
2	12-7-23	23-7-23	11	8-8-23	16	15-8-23	7	34	1♀
3	12-7-23	20-7-23	8	7-8-23	18	16-9-23		35	1♀
4	24-7-23	7-8-23	10	20-8-23	17	5-9-23	16	43	1♀
5	24-7-23	21-7-23	7	18-7-23	18	26-7-23	8	33	2♂
6	24-7-23	1-8-23	8	17-8-23	16	28-8-23	11	34	2♂
7	24-7-23	4-8-23	11	21-8-23	17	29-8-23	8	36	5♀
8	7-8-23	14-8-23	7	31-8-23	17	9-9-23	9	33	3♂
9	10-8-23	16-8-23	6	3-9-23	18	18-9-23	15	39	1♂
10	11-8-23	20-8-23	9	6-7-23	15	15-9-23	14	38	2♂
11	17-8-23	23-8-23	6	10-9-23	18	18-9-23	8	32	2♀
12	15-10-23	26-10-23	11	10-9-23	14	21-11-23	14	36	5♀ 3♂
13	29-3-24	6-4-24	14	..	..	12-5-24	..	50	1♂
14	25-3-24	8-4-24	14	1-5-24	23	17-5-24	16	53	1♀
15	25-3-24	5-4-24	11	..	.	12-5-24	..	51	1♂
16	28-3-24	9-4-24	12	..	..	14-5-24	..	47	1♀ 1♂
17	31-3-24	8-4-24	8	26-4-24	16	13-5-24	17	43	1♂
18	31-3-24	9-4-24	9	..	..	13-5-24	..	43	1♀
19	31-3-24	9-4-24	9	..	..	14-5-24	..	44	3♂
20	31-3-24	8-4-24	8	..	..	10-5-24	..	40	1♂
21	31-3-24	15-4-24	15	..	..	15-5-24	..	45	1♂
22	31-3-24	8-4-24	8	23-4-24	15	9-5-24	16	39	1♂
23	1-4-24	14-4-24	13	..	..	15-5-24	..	44	2♀
24	1-4-24	16-4-24	15	..	..	17-5-24	..	46	1♀ 3♂

Statement showing the duration of various stages of Aulacophora abdominalis—contd.

Serial No.	Date of oviposition	Date of hatching	Egg stage (days)	Date of pupation	Larval stage (days)	Date of emergence	Pupal stage (days)	Total duration of life cycle	No. and sex of beetle emerged
25	1-4-24	14-4-24	13	..	..	17-5-24	..	46	1♀ 4♂
26	1-4-24	16-4-24	15	..	..	17-5-24	..	46	1♀ 4♂
27	2-4-24	15-4-24	13	..	..	15-5-24	..	43	2♀
28	2-4-24	15-4-25	13	..	..	16-5-24	..	44	1♀
29	2-4-24	14-4-24	12	..	..	16-5-24	..	44	1♀ 1♂
30	2-4-24	15-4-24	13	..	..	17-5-24	..	45	1♀ 1♂
31	2-4-24	15-4-24	13	..	..	19-5-24	..	47	1♀
32	3-4-24	13-4-24	10	..	..	14-5-24	..	42	1♀ 2♂
33	3-4-24	13-4-24	10	..	..	15-5-24	..	43	1♀
34	3-4-24	13-4-24	10	..	..	16-5-24	..	43	1♀
35	5-4-24	16-4-24	11	..	..	16-5-24	..	41	1♀ 3♂
36	5-4-24	15-5-24	10	..	..	17-5-24	..	42	4♀ 7♂
37	5-4-24	16-4-24	11	..	..	19-5-24	..	44	1♀ 1♂
38	5-4-24	15-4-24	10	..	..	19-5-24	..	49	2♀ 5♂
39	6-4-24	16-4-24	10	..	..	8-5-24	..	32	1♂
40	8-4-24	19-4-24	11	..	..	23-5-24	..	45	1♂
41	..	14-4-24	..	30-4-24	..	15-5-24	15	..	1♀
42	9-4-24	17-4-24	8	8-5-24	21	23-5-24	15	44	1♀
43	16-4-24	25-4-24	9	..	..	28-5-24	..	42	1♀
44	23-4-24	30-4-24	7	..	..	2-6-24	..	30	1♀
45	24-4-24	3-5-24	9	..	..	2-6-24	..	38	1♀ 2♂
46	24-4-24	3-5-24	9	..	..	3-6-24	..	39	1♂
47	24-4-24	3-5-24	9	..	..	5-6-24	..	41	1♀ 3♂
48	25-4-24	3-5-24	8	21-5-24	18	5-6-24	15	41	1♂
49	26-4-24	5-5-24	9	..	..	3-6-24	..	39	1♂
50	26-4-24	5-5-24	9	..	..	5-6-24	..	41	2♂
51	2-5-24	9-5-24	7	22-5-24	13	7-6-24	16	36	1♀

4. Seasonal-History. (Pl. XIII).

(1) Time of appearance. The beetles begin to come out of hibernation in the beginning of March, or earlier if the temperature is favourable, and their number continues to increase, reaching the maximum about the middle of April. This brood entirely consists of the beetles which had emerged during the previous August and September and possibly October and had remained in hibernation during the cold season. By the end of April the beetles of this particular "overwintered" brood begin to disappear, but thay have been depositing eggs during March (last

week) and April and large numbers of larvæ and pupæ can be seen during April and May.

(2) Number of generations. The adults of the first spring brood begin to appear about the end of April and by the middle of May they are present in large numbers and reach their maximum strength about the end of May and beginning of June and continue to live till the beginning of July. By the middle of June the second brood begins to appear, and by the beginning of August the third brood makes its appearance. Thus by the end of August and beginning of September the adults of the second and third and not infrequently those of the fourth brood are present in the fields. Damage to the rainy season crop is mainly due to the beetles of these broods. There is a brood emerging in the beginning of September and the last brood appears about the middle of October. Thus there are five generations of these beetles during the year, but as the adults live for a considerable time and continue to lay eggs the broods greatly overlap. All the stages of the beetles are met with in the fields right from the beginning of April to the end of September or even middle of October. In October and November the adults begin to seek, shelter and their number falls. Early in November the beetles are seen feeding during the warmer part of the day only, and sit inactive concealed among leaves and creepers during mornings and evenings. Later in the season they are only found in their places of hibernation.

5. Hibernation.

(1) Stage in which the insect hibernates. During the winter months the fields where the cucurbits had been growing and where the adult beetles, as well as, all the other stages of *A. abdominalis* were abundantly found, were carefully searched for eggs, larvæ and pupæ. No eggs were discovered but after prolonged search a few larvæ and pupæ were found. Thus it appears that in the Punjab, *A. abdominalis* hibernates in the adult stage, and the hibernating beetles most probably consist of individuals belonging to three or even four successive broods.

Period of hibernation. From October onward the activities of the adult beetles become restricted and by November they enter into hibernation and remain in this condition till the beginning of March. Thus the majority of beetles remain in hibernation for over four months.

(2) Place of hibernation. The beetles hibernate, singly or in groups, usually among the curled up leaves and twigs of dried cucurbit creepers, but they readily take shelter among grasses, weeds, bushes, etc. During December, January and February they have been found hibernating in *Cana indica,* mulberry bushes, lucerne, brinjal, cotton, citrus, gram, cabbages, turnips and numerous weeds and grasses. In fact, any place that can provide safety from the severity of winter is availed of and often the adults are found in crevices in the soil. The uprooted cucurbit creepers or other plants which are usually piled on the boundaries of fields provide a very suitable shelter and are, therefore, a source of great danger.

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(3) Proportion of sexes in hibernating beetles. A large number of beetles were collected at different times during the hibernation season and relative proportion of the sexes determined. Of 825 beetles collected during December 1923 and January 1924, 475 were females and 350 males, and of the 2,222 bettles collected during December 1924 and January and February 1925, 1,112 were females and 1,110 males. Thus the sexes hibernate almost in equal numbers.

(4) Mortality among hibernating beetles. The beetles collected during December 1924 to February 1925 were kept in wire gauze cages in the laboratory. On the 25th February it was found that about 67 per cent. of them had died and by the 3rd March, when a few beetles were seen flying about in the fields and the hibernation period was taken to be over, the proportion of survivors was no more than 25·3 per cent. Thus the mortality amongst the hibernating beetles was very high even in the laboratory where the temperature was higher than that prevailing outside in the fields.

To discover the condition under natural surroundings, 1,050 beetles were collected during October and placed in four wire gauze cages kept in the fields. Dried creepers with crumpled leaves were placed in these cages to provide shelter for the hibernating beetles. The results are given in the table below :—

	No. of beetles introduced	No. of beetles which survived hibernation
Cage No.		
1	300	90
2	500	75
3	150	30
4	100	[illegible]0

Thus only 19·5 per cent. beetles survived.

Again a large number of beetles were introduced in wire gauze cages placed in the fields, but no shelter of any kind was provided, and it was found that of the numerous beetles introduced not one survived the winter. This clearly shows that mortality is very high during hibernation and without proper shelter the beetles succumb to cold. This demonstrates the importance of clean cultivation and of destroying every possible shelter for the hibernating beetles.

(5) Proportion of females fertilized before hibernation. Of the hibernating female beetles 49 were dissected during January 1924 and it was found that as many as 10 of these had been fertilized previous to hibernation and contained living sperms in their spermathecæ. During the winter of 1924-25, 400 beetles were dissected but only 25 contained sperms. From these figures it appears that in some cases at any rate copulation had taken place before the beetles hibernated, and these very likely belonged to third and fourth broods.

(6) PROPORTION OF SEXES AFTER HIBERNATION. As mentioned above the males and females hibernated in equal numbers and during the period of hibernation this proportion was maintained, but after hibernation a very large number of males died. Over 3,000 beetles were collected during the first fortnight of April 1925 and the relative proportion between males and females was found to be 1 : 6.

6. FOOD-PLANTS.

There exists some confusion regarding the food-plants of *Aulocophora abdominalis*, Fb. Cotes (4, 5) mentions it as destroying cotton, red gram, cucumber, *sanghara* (*Trapa bispinosa*) and paddy and summarizes the available information on *A. abdominalis* in the following : " 65. *Aulacophora abdominalis*, Fabr. A small yellow beetle, reported from Saharanpur as attacking Cucurbitaceæ of all kinds ; from elsewhere in the North-Western Provinces it has been reported as attacking water caltrop (*Trapa bispinosa*) ; from Ganjam it has been reported as attacking cotton (*Gossypium herbaceum*), gram (*Cicer arietinum*) and cucumber (*Cucumis sativus*) ; from Nuddea it has been reported as ' injurious to plants and vegetables '; while from Hooghly it has been reported as attacking paddy (*Oryza sativa*) " (6). Lefroy (14 p. 201) says, " The Red Pumpkin Beetle....is found attacking melons, gourds, cucumbers, and other cucurbitaceous plants. It is not limited to these plants, but is a common pest in gardens and in small patches of irrigated lands." Fletcher (8) states :—" *Aulacophora abdominalis* has been also noted on lucerne, but there seems to be some doubt about the identity of the species concerned and *A. abdominalis* is not a pest of lucerne as far as we know."

Evidently, therefore, either some other beetle has been confused with *A. abdominalis* or the mere presence of this insect on a plant has been regarded a sufficient proof of its guilt. The case of *Trapa bispinosa* is certainly that of mistaken identity, because the real pest of this plant *Galerucella singhara*, Lefroy, resembles closely *A. abdominalis* in general form and colour.

Specimens of adult beetles have been collected from different plants such as maize, gram, cabbage, egg plant, amaranthus, jute, sweet potato, turnips, mulberry, mango, citrus, guava, lucerne, shaftal, *Cana indica*, and a number of weeds and grasses, but in no case was any damage noticed. Actual experiments were tried and leaves of the plants given below were provided to the adult beetles kept in glass dishes in the laboratory. While the beetles provided with melon leaves ate their food voraciously, those provided with leaves of other than cucurbitaceous plants refused to eat and died of starvation.

Plants refused by *A. abdominalis* in captivity :

Coniferæ—*Pinus longifolia*.
Cannaceæ—*Canna indica*.
Cyperaceæ—*Cyperus tuberosus*.

Gramineæ—*Triticum sativum; Hordeum vulgare; Avena sativa; Oryza sativa; Saccharum officinarum; Cynodon dactylon; Sorghum halepense.*

Palmaceæ—*Phœnix dactylifera.*

Leguminosæ—*Lens esculenta; Cicer arietinum; Lathyrus sativus; Trigonella faenum-graecum; Medicago sativa; Trifolium resupinatum; Trifolum alexandrinum; Melilotus parviflora; Medicago denticulata*; *Lathyrus odoraties; Pisum sativum; Dalbergia sissoo; Acacia arabica; Acacia modesta; Albizzia labbeck.*

Cruciferæ—*Brassica campestris* var. sarson; *Brassica* var. Toria; *Eruca sativa; Cheiranthus cheiri; Iberis* sp.; *Brassica oleracea* var. botrytis; *Brassica oleracea; Brassica oleracea caulo-rapa; Brassica rapa;* ***Raph**anus sativus; Daucus carota.*

Malvaceæ—*Gossypium* sp.; *Hibiscus esculentus; Hibiscus Rosa-sinenis; Althea rosea; Malva parviflora;*

Chenopodiaceæ—*Chenopodium album; Chenopodium murale; Beta vulgaris* var. *orientalis.*

Amarantaceæ—*Digera arvensis.*

Solanaceæ—*Solanum tuberosum; Lycopersicum esculentum; Solanum melongena; Solanum nigrum; Capsicum frutescens.*

Rosaceæ—*Rosa indica; Eriobotrya japonica; Pyrus communis; Pyrus malus.*

Urticaceæ—*Ficus religiosa; Ficus indica; Ficus carica.*

Rutaceæ—*Citrus aurantium* var. Malta; *Citrus limonum; Citrus aurantium.*

Myrtaceæ—*Eugenia jambolana; Psidium guava; Punica granatum.*

Convolvulaceæ—*Convolvulus arvensis. Canvolvulus* sp.

Vitaceæ—*Ampelopsis hederacea. Vitis vinifera;*

Apocynaceæ—*Nerium oleander.*

Moraceæ—*Morus alba;*

Anacardiaceæ—*Mangifera indica.*

Cucurbitaceæ—*Momordica charantia.*

Asclepidaceæ—*Calotropis procera.*

Rhamnaceæ—*Zizyphus jujuba.*

Tiliaceæ—*Grewia asiatica.*

Boraginaceæ—*Cordia myxa; Helionopium supinum.*

Euphorbiaceæ—*Ricinus communis.*

Compositæ—*Lactuca sativa.*

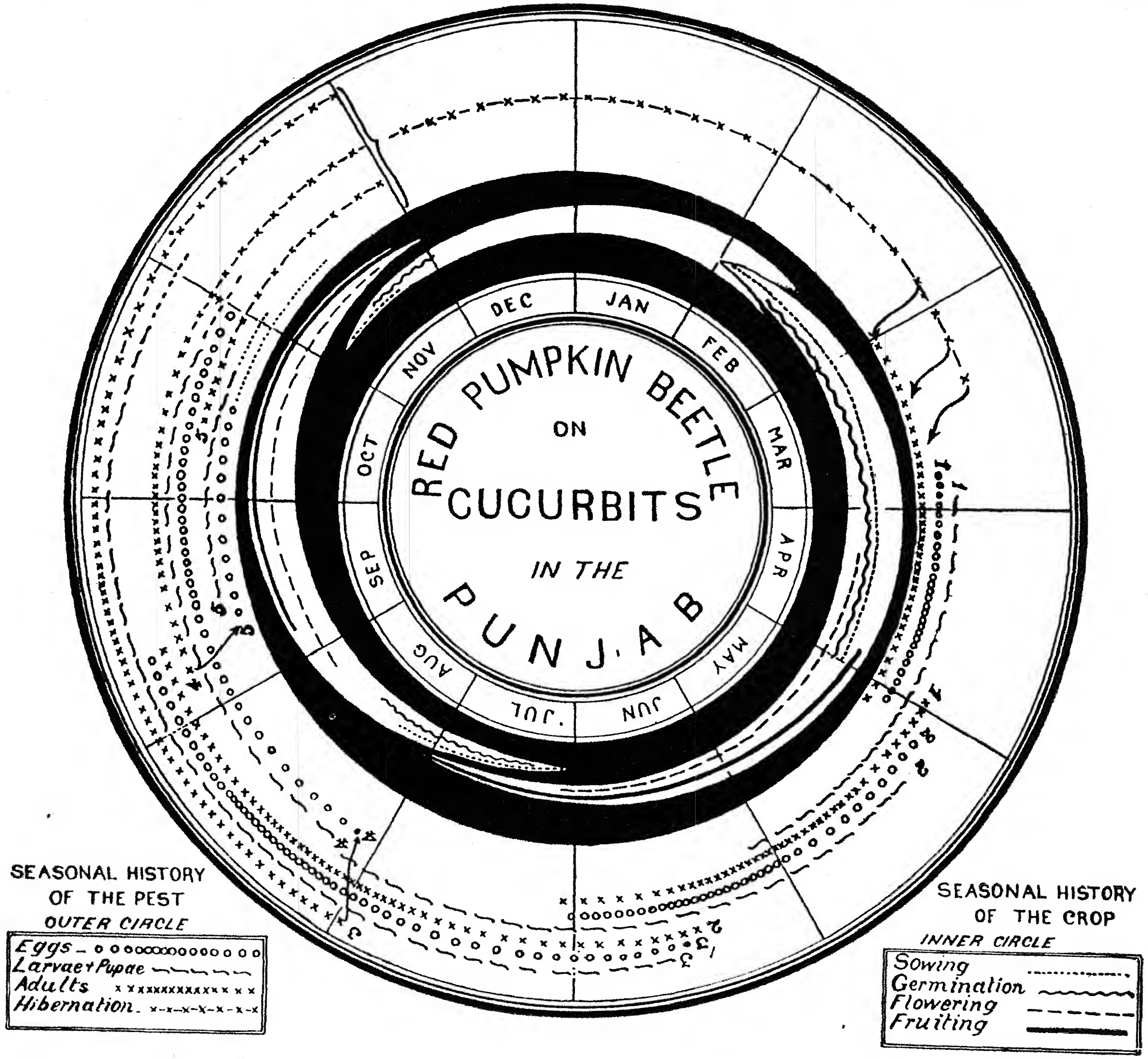
It was noticed that after a few days' starvation the beetles would nibble at and even eat a little of the leaves of:—

Lathyrus odoratus; Pisum sativum; Medicago sativa;
Trifolium rempinatum; Oryza sativa; Zea mays;

but they could not live on these.

PLATE XIII.

WHITE CRESCENTS ON BLACK GROUND INDICATE THE CROPS: FIGURES INDICATE EGGS, PUPÆ AND ADULTS OF VARIOUS BROODS.



Till definite evidence is forthcoming it might be stated that *A. abdominalis* feeds exclusively on the plants belonging to the natural order Cucurbitaceæ, and at Lyallpur it has been known to feed on the plants given below :

Botanical name	Common English name	Vernacular name (Punjab)
Cucumis melo, Linn.	Musk Melon	Kharbuza.
Cucumis momordica, Roxb.	Melon	Phut, Khakhari.
Cucumis sativus, Linn.	Cucumber	Khera.
Cucumis utilissimus, Roxb.	....	Tar, Kakri.
Cucumis madraspatanus, Roxb.	....	Kachri, Chibbar.
Cucurbita maxima, W. & A.	Pumpkin vegetable marrow.	Halwa Kadu, Kanshi Phal.
Citrullus vulgaris, Schrad	Water melon	Tarbuz, Hindwana.
Citrullus vulgaris, Schard, var. *fistulosus,* Stocks	....	Tinda.
Benincasa cerifera, Savi	White gourd melon	Petha.
Lagenaria vulgaris, Seringe	Bottle gourd	Ghia, Kadu.
Luffa aegyptiaca, Mill.	Luffa, Spong gourd	Ghia, tori.
Luffa acutangula, Roxb.	Ribbed gourd	Mongi or kali tori.
Trichosanthes anguina, L.	Snake gourd	Chachinda.

All the three species of *Aulacophora* (pages 33-34) have been mentioned as pests of *Momordica* sp. in South India (7, 8, 9), but it must be pointed out that of the cultivated cucurbitaceæ *Momordica charantia* L. (Bitter gourd 'Karela') is not attacked by *A. abdominalis* and *A. atripennis*, and all attempts to feed adults on leaves of this plant have so far failed. This may be due to the presence of some unpalatable principle in this plant.

IV. SEASONAL-HISTORY OF THE CUCURBITACEOUS CROP. (Pl. XIII).

Usually two crops of cucurbits are grown in the Punjab ; the first crop is sown during February, March and April, and is the more important of the two. The second crop is put in about the end of June or the beginning of July, before the monsoons set in. In some cases, as for gourds, the first crop is over before the end of July but the same crop is ratooned and fresh vegetative growth starts during the rains. The growth of the plants is naturally very quick during and after the monsoons.

In neighbourhood of large towns the vegetable growers often sow an early crop of gourds, pumpkins, etc., in November, and erect a hedge of straw to reflect the rays of the sun on to the seed bed and germinating crop. Growth is very slow in winter but by the middle of March the plants are well developed and yield a very early crop of fruits in the beginning of April.

The spring sown crop begins to flower about the middle of April and fruiting starts about the end of April.

The crop sown before the rains germinates within three or four days and during the rains the growth is very vigorous. The flowers appear about the end of August and fruiting begins about the middle of September. Thus the food plants remain in the fields throughout the period of the activities of the beetles. (Pl. XIII).

V. DAMAGE.

The adult beetles feed on the leaves of cucurbits, and show special preference for the soft and tender ones (Pl. XII, fig. 8). In cases of severe attacks all the leaves of a seedling or a young creeper are completely eaten up and the defoliation is so thorough that the plants do not survive. In older vines, however, the beetles only eat holes in the leaves and as the vegetative growth is very vigorous and as broad leaves are produced in quick succession, the damage is never very serious. The greatest damage, therefore, is done to the germinating crop or young vines, and this is particularly true of the spring crop. The beetles come out of hibernation and become active about the time when the seeds sown in February are just germinating and each plant has two or three leaves which they eat up and the seedling is killed. In some cases not a single seedling of the first crop is left. The vegetable growers continue to put in seeds in place of the seedlings lost. This operation has to be repeated so often that in many cases it may safely be said that the whole field is sown three or four times.

The beetles of the second and third spring broods attack the second crop sown in the rains, but the damage done is not so serious as in the above mentioned case.

The special crop of gourds and pumpkins sown in November does not suffer so heavily because the vines are already well developed when the beetles appear after hibernation.

The adult beetles attack the flowers also and cause considerable loss of fruit.

The larvæ bore into the roots and stems and when present in large numbers they are responsible for the death of a large number of seedlings. The attacked plants wither and die. The observations in the field were confirmed by actual experiments in the laboratory. Seeds were planted in an earthen pot and allowed to germinate, and after a few days a number of freshly hatched grubs were placed in this pot. They at once started attacking the seedlings and ate up the portion just below the soil and the seedlings died within 15 days, and not one out of the 20 seedlings survived.

The grubs also bore into the fruit starting their attack at the portion resting on the ground. The fruit is marked and becomes unmarketable, or at any rate, does not fetch the same price as a sound one. At times the attacked portion becomes hard and discoloured. At Hoshiarpur and Jullandhar it was noticed that 2-5 per cent. of the fruits of water-melons, gourds, pumpkins, cucumber, etc., were marked. In the case of melons it has been noticed that the damage to the fruit is sometimes very serious, and up to 35 per cent. of the fruits may be marked, this is particularly true of the comparatively low lying places in the fields, where water stands for a longer period.

From the above it will appear that it is the adult stage which is responsible for the main damage and it is chiefly the beetles coming out of hibernation in the beginning of the Spring that cause the most serious losses. They appear in large numbers just when the crop is germinating and attack the young seedlings. As many as 20 beetles have been seen attacking a seedling with 3 or 4 leaves. Thus there is very little chance for the plant.

VI. CONTROL MEASURES.

The study of the seasonal-history of the pest in relation to the seasonal-history of the crop leads one to the conclusion that the beetles coming out of hibernation cause the greatest damage, as they appear at the time when the spring crop of cucurbits is just coming up. Moreover these beetles are the parents of the future broods which cause serious damage later on. It is, therefore, advisable to employ means of protecting the crop and destroying the pest at this stage. It will be clear, from what has been said above, that this pest can be effectively and economically dealt with only in the adult stage. Therefore, the various methods of dealing with the adult beetle shall be discussed first.

1. Control measures against adult.

(1) Repellents. The practice of throwing ashes over germinating and young cucurbits, to protect them from the ravages of leaf eating insects, is common among the vegetable growers and farmers in India. Ashes act as repellent and there is no doubt that insects, to a certain extent, do avoid plants so treated, but in absence of other available food supply they usually overcome their abhorence and either select leaves free from dust or start their attack from the lower surface where the ashes have not reached. Addition of a little kerosene, however, improves the repellant properties of ashes. Other common substance which can be used for the purpose are dry slaked lime and tobacco dust. The latter has the additional value of being a very good manure. Lime and tobacco dust are usually diluted with ashes or road dust.

(2) Dusting stomach poisons. Repellents, however effective, are not of very great value. Insects repelled from the plants covered over with dust congre-

gate on to the plants not so treated and being present on fewer plants in large numbers cause very great damage. Further, as the repellents do not contribute towards reduction in the number of beetles any new leaves that appear are subjected to a very severe attack and considerable loss is the result. It is therefore, advisable that plants should be treated with some substance which will kill the beetles. Paris-green mixed with ashes or fine road dust, in the proportion of 1 : 8 by weight, was found to be the most effective of all the dusting powders tried. Paris green 1 : 32 or Lead arsenate 1 : 30 also gave very satisfactory results.

As the growth of the cucurbit plants is very rapid, particularly during the rainy season, experiments were performed to find out the duration of the efficacy of one dusting. A melon vine grown in a pot was selected and dusted over with Paris green and road dust (1 : 8) and covered over with a wire gauze cage. Beetles were introduced into the cage from time to time. It was noticed that the effect of a single dusting lasted for 5 days.

The cost of dusting one acre of melons for one month was also worked out. In all six dustings were given. For the first operation a stronger dose of poison was used (1 in 8 of road dust) so that the insects died after eating even a small quantity of the poisoned leaf. In subsequent dusting the proportion of Paris green was reduced to 1 in 32 of road dust. The cost of dusting one acre of melons six times comes to :—

	Rs.	A.	P.
One man for 12 hours at 12 annas per day of 8 hours	1	2	0
Paris green 9 chataks at Rs. 8 per seer	4	8	0
TOTAL	5	10	0

One man can with the Feeny dusting machine cover an acre in 2 hours, and road dust costs nothing.

For efficient operation a dusting machine is essential but when one is not procurable an improvised dusting apparatus can be used fairly effectively. Any receptacle which is handy can serve the purpose (Pl. XIV, figs. 1, 5). Even small cheese cloth bags can be used. One operator can use two bags (fig. 4) at a time and by means of a simple contrivance, consisting of a pole to which the required number of bags is tied, more than two rows may be dusted at one time. While dusting a repellent or a poison mixture the following few points should be borne in mind :—

1. Dusting should always be done early in the morning on leaves wetted with dew.
2. The dust used must be very fine so that it adheres to the leaves.
3. As far as possible every part of the plant should be completely covered with dust. With the dusting machine this is done quite easily, but with an improvised apparatus it is rather difficult. Advantage can be taken of a slight breeze for blowing the dust in to the interior of the plant by jerking the bag a little away from the plant on the side from which the breeze is blowing.

1

Various vessels that can be used for dusting.

4

Dusting by means of cheese cloth bags.

2

3

Dusting machine in operation.

5

Dusting with one of the vessels shown in 1.

4. Dusting should be repeated after every shower of rain.
5. Dusting should not be attempted on a windy day.

(3) SPRAYING. If a spraying machine is available any of the well known stomach poison may be sprayed. The following insecticides may be tried :—

1. Lead arsenate mixture—		
Lead arsenate	1	part by weight.
Lime	3	parts ,,
Molasses	6	,, ,,
Water	600	,, ,,
2. Tobacco decoction—		
Tobacco (refuse)	6	,, ,,
Soap	$1\frac{1}{2}$	,, ,,
Water	600	,, ,,

Spraying should be done before the attack begins and repeated every six days for the first month.

(4) HAND PICKING OR COLLECTING WITH HAND NETS. If nothing else can be done the beetles may be hand picked. This gives excellent results particularly in the beginning of the season when plants are young and beetles are not so numerous. This operation should be performed in the mornings when the temperature is low and beetles are sluggish, as is the case in March in the Punjab. During warmer parts of the day hand nets may be tried. These simple operations should not be neglected, particularly over small areas. Rapid increase in the number of beetles is prevented and chances of severe losses are greatly minimised

When beetles are present in large numbers on young plants they can be easily collected by shaking them into shallow pans containing water and kerosene. This should be done during the cooler part of the day, preferably morning. In one particular experiment 9,273 beetles were destroyed, from a melon field of two acres by one man working 3 hours a day on three successive days. He worked for one hour each time, morning, noon and evening. The largest number of beetles were taken in the mornings, and fewest at midday. The results are tabulated below :—

Date	Time	Beetles collected	TOTAL
10th April 1925	Morning	2,000	
	Noon	100	
	Evening	547	2,647
11th April 1925	Morning	3,541	
	Noon	142	
	Evening	900	4,583
12th April 1925	Morning	1,237	
	Noon	76	
	Evening	730	2,043
			9,273

(5) TRAP CROP. A few plants of some cucurbit should be planted early so that they are well above the ground when beetles come out of hibernation and they should be dusted with a strong dose of stomach poison. The beetles coming out will feed on these and shall get poisoned or they can be dealt with in some other effective manner. Similarly when the rainy season crop is being removed a few vines should be kept and dusted with strong poison. The beetles before going into hibernation will collect on these plants and eat the poisoned leaves and die.

2. CONTROL MEASURES AGAINST GRUBS AND PUPÆ.

(1) SOIL FUMIGATION. Various experiments with carbon bisulphide, petrol and kerosene were tried but it was found that soil fumigation was not an economic proposition. If, however, it is necessary to kill the grubs this can be done most cheaply by pouring strong tobacco decoction round the roots of the plants.

(2) FLOODING THE FIELDS. Flooding the fields besides being harmful to the crop was not effective in killing grubs and pupæ. A field two '*marlas*' in area was flooded for two consecutive days and it was found that the mortality among the grubs was not higher than 5 per cent. and the pupæ were all safe. Heavy rains did not have any evil effect on the pest. In a particular instance it rained heavily in August for two days and yet observations taken after the rains showed that the larvæ and pupæ did not suffer much.

(3) PLOUGHING THE FIELD AFTER THE CROP. The only satisfactory method of destroying the pest in its grub or pupa stage is to plough the fields after the spring crop is harvested. This operation exposes grubs and pupæ, which are greedily devoured by crows and other birds. It must be borne in mind that a very large number of grubs and pupæ remain in the clods and thus escape destruction. Clods should, therefore, be broken by means of *sohaga*. It was, however, found that some of the grubs and pupæ escaped injury even after the clods had been broken, and remained concealed being covered over with soil. It is, therefore, essential that ploughing should be thorough, and the field should be harrowed once or twice.

3. CLEAN CULTIVATION.

Crop remnants are a veritable source of every kind of plant disease. Cultivators should make it a point to keep their fields free of all rubbish, and dead plants. It is a common practice with farmers and vegetable growers to leave cucurbit creepers in the fields after the crop has been harvested. During summer these creepers provide food for the grubs which feed on the roots, stems, rotten leaves and even fruits and they also produce good crop of leaves for the adults. During winter the dried up creepers provide an excellent shelter for the hibernating beetles. It is, therefore, essential that after the spring crop is over the creepers should be pulled out and destroyed, and the fields ploughed up and harrowed, so as to expose grubs and pupæ. The creepers of the rainy season crop may be left in the field till Nov-

ember and then pulled out and collected at one place ; and, when the beetles have taken refuge in them for hibernation, this heap of creepers should be covered over with straw and set on fire. In some cases it was noticed that the beetles flew out of this smouldering heap. To guard against this it is necessary to cover the heap with plenty of straw so that the beetles cannot find an easy exit.

Further all places where beetles find shelter for hibernation should be dealt with. Ploughing the fields and safe disposal of crop remnants if done systematically will save the farmer from the ravages of a large number of crop pests including *A. abdominalis.*

4. Use of manures and fertilizers.

Very often a vigorous growing plant outgrows even a severe attack of a pest and if manures and fertilizers are used to stimulate growth in cucurbits, the serious consequences of beetle attack can be overcome.

5. Sowing early varieties.

It has been mentioned above that the beetles come out of hibernation about the beginning of March and if by then the plants are well established the damage done is not serious. It is therefore advisable to sow early varieties or to sow ordinary varieties early so that the creepers have plenty of leaf before the beetles appear.

6. Growing excess of seed.

As mentioned above, the cucurbit crops have often to be sown twice, thrice or even four times because of the attack of the Red Pumpkin Beetle. The farmers usually put in a seed in the place of a seedling lost and very often this continues for so long a time that proper sowing season is over. Sometimes excess of seed is sown but then three or four seeds are put in together in the same place at the same time, and all the seedlings which must come up together meet the same fate and are eaten by the beetles; therefore, from entomological point of view, it is no gain. It has been suggested that the seeds should be sown in groups of four during the four successive weeks, every seed being put in each week in the following manner— $\begin{array}{c|c} 1 & 2 \\ \hline 3 & 4 \end{array}$. Thus seeds will germinate with a week's interval between each sowing and there are chances of at least one out of the four seedlings remaining safe. If the crop is too thick it can be thinned later on. If required the first crop can be used as a trap crop. This system will ensure a crop without unnecessary delay (3).

7. Covering the germinating and young plants.

In some countries the germinating and young plants are covered with cheap wire gauze covers of various designs (3). This is a very useful device for a small plot and for those who grow vegetables for the market, because these covers can be used for protecting other vegetables, seed beds, etc.

8. Hanging crumpled paper.

It has been stated that if a crumpled paper is hung over the plants, it is kept dangling by the breeze and beetles get frightened and do not attack the plant (16). This was not found very effective at Lyallpur.

9. Natural enemies.

Except crows, 'mynas' and some other birds, which pick up grubs and pupæ when they are exposed by ploughing or harrowing, no predators and parasites have so far been noticed.

It has, however, been found that adult beetles often contain large numbers of gregarian parasites in the alimentary tract, but these do not seem to have any evil influence on their host (2). Certain mites have also been seen on the bodies of these insects.

VII. *AULACOPHORA ATRIPENNIS*, FB. (Pl. XII, figs. 7, 7*a*).

With the Red Pumpkin Beetle (*A. abdominalis*) there occurs another species *A. atripennis*, Fb. (*excavata*, Baly) which can be easily distinguished from the former by its black elytra. It is never present in such large number as *A. abdominalis*.

In its habits and life-history it very much resembles *A. abdominalis*. Although it has been definitely mentioned as a pest of "all cucurbitaceous plants" (7) particularly *Cucurbita*, *Cucumis* and *Citrullus* (8), yet at Lyallpur, in fields, it is known to feed only on *Luffa œgyptiaca* and *L. acutangula*. This was confirmed by experimental evidence. Adult beetles were confined in glass cages and supplied with leaves of *Laginaria vulgaris*, *Cucumis sativus*, *Citrellus vulgaris*, *Benincasa cerifera*. *Citrullus vulgaris* var. *fistulosus* *Cucumis melo* var. *utilissmia*, *Memordica charantia*, and *Tri- chosanthes anguina*, but they refused to eat them and died of starvation Leaves of *Cucumis melo*, and *Cucurbita maxima* and in some cases those of *T. anguina* were, however, eaten after two days' starvation. In the control cages where leaves of *Luffa aegyptiaca* and *L. acutangula* were supplied the beetles continued to feed all through the experiment. The above trials of food plants were repeated twice with exactly the same results.

In another experiment a leaf of each of the above mentioned cucurbits was placed in a dish and a number of beetles introduced; on the second day it was noticed that while the leaf of *Luffa aegyptiaca* was completely eaten the leaves of all the other cucurbits were not touched.

The following common cultivated plants were also tried, but the beetles did not eat any of these :—

Gramineæ—*Oryza sativa*, *Zea mays*, *Saccharum officinarum*, and *Andropogon sorghum*, *Pennisetum typhoideum*.

Leguminosæ—*Medicago sativa*; *Trifolium resupinatum*.

Malvaceæ—*Gossypium* sp., *Hibiscus esculentus.*
Solanaceæ—*Solanum tuberosum ; S. melongena, capsicum frutescens.*
Convolvulaceæ—Iporieæa batatus.

VIII. SUMMARY.

Aulacophora abdominalis, Fb. has a very wide distribution. It has been reported from both the shores of the Mediterranean, Sudan, Ceylon, Mesopotamia, Australia and occurs all over India.

In the Punjab it attacks all the cultivated cucurbits (except *Momordica charantia*) and does extensive damage.

The life-history may be briefly summarised as follows :—

Small, rounded, yellow eggs are laid on moist soil round the base of the food plant. The egg stage lasts from 6—15 days. The small, whitish larvæ as they come out of the egg bore into roots, stems and fruits, and also feed on leaves lying on the soil. In 13—23 days larva becomes full grown and enters the soil to pupate in an oval chamber which is made impervious to water by some sort of secretion.. The pupal stage lasts from 7—17 days. The adults live for about a month (except those that hibernate) which live for over 5 months and continue to feed and lay eggs. There are 5 generations during the year. The adults *A. abdominalis* are orange red in colour and *A. atripennis* have black elytra.

Adult beetles hibernate under old cucurbitaceous creepers, among bushes, grasses and weeds and even in crevices in the soil, and remain in this condition from the middle of October to the beginning of March.

The beetles become active during March and April and continue to feed on leaves, eat up the tender leaves of the germinating or young cucurbits and so completely defoliate them that the entire crop is lost, and sometimes the seed has to be sown three or four times. The beetles lay eggs on moist soil, round the bases of cucurbitaceous plants, and the larvæon hatching out enter the roots and stems and kill the seedlings thus adding to the damage caused by the beetles.

Beetles of the next broods do comparatively little damage because the creepers are well developed and growth is so rapid that loss of leaves eaten is made good very soon. The beetles of the second and third spring generations are mainly responsible for the attack on the July sown cucurbits.

Larvæ although far less destructive than adults often cause serious losses by boring into the roots and stems of seedlings and young plants, and by marking the fruits.

As the beetles coming out of hibernation in the spring are most destructive and are the source of future evil, efforts should be made to deal with them. Use of repellents is effective in saving the plants, and ashes, slaked lime or road dust may be used mixed with tobacco dust or kerosene.

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Stomach poisons, however, give better results as they kill the insects. Paris green, or Lead arsenate may be dusted or sprayed. Tobacco decoction has also given good results. Dusting or spraying must be repeated every 5th or 6th day so that the new leaves are covered.

It is recommended that a few early plants be grown to serve as a trap crop. The beetles as they come out of hibernation will be attracted to these and can then be killed by the use of some stomach poison or contact poison. This trap crop may also be used for attracting the beetles to a few plants for hand picking. Hand picking during colder parts of the day gives good results.

Ploughing the fields, after the spring crop has been harvested, is effective against the larvæ and pupæ as these are exposed to the sun and are also readily picked up by birds. Ploughing must be thorough and the clods should be broken, and harrowing should be done once or twice.

Clean cultivation should be insisted upon and all old creepers, grasses, bushes, etc., which serve as shelter for the hibernating beetles should be destroyed. Collecting creepers in November and keeping them till such time that most of the hibernating beetles have gathered on them and then setting them on fire would help to destroy the adults.

Early varieties if obtainable should be sown, and their growth stimulated by use of manures so that by the time adults come out of hibernation the plants are well established and have sufficient of leaf to withstand attack or outgrow it.

The practice of sowing four seeds close together during four successive weeks ensures a crop and should be tried.

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EXPERIMENTS ON THE TRANSMISSION OF RINDERPEST BY MEANS OF INSECTS

BY

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INTRODUCTION.

I. The transmission of rinderpest by arthropods: the need of epidemiological studies.

Except for the experiments carried out by Curasson[1] in Poland, no notable attempt appears to have been made to transmit rinderpest by means of arthropods. Curasson experimented with the tick, *Ixodes ricinus* and with a species of *Tabanus*. An engorged tick was removed on the second day of the fever and ground up in salt solution, and the extract, when injected into a healthy animal, produced infection, but the results were negative when the tick was ground up an hour after removal. Results with Tabanids were all negative.

The experiments of Ward and his collaborators,[2] although not conducted with insects, are of interest and their main conclusions are quoted here :—

(1) Rinderpest virus does not survive beyond 24 hours in corrals, bare of vegetation, but containing water.

(2) Animals become infected in such corrals within half an hour, twelve hours and seventeen and one-half hours, respectively, after removal of the sick.

(3) Transmission is possible by close contact only during the febrile period of disease and most certainly during the period in which the temperature is declining. Disease is not contracted in contact with convalescent animals.

(4) Blood was shown infected in two cases during the height of febrile period.

(5) The virus in urine, diluted with water and sprinkled on grass, was demonstrated to survive for 36 hours in some instances, but not always, and not for a longer period.

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[1] *Rev. Gén. Méd. Vét.*, XXXI, pp. 57-60 (1922). [Abstract in *Rev. App. Entom.*, B, X. p. 155 (1922).]

[2] *Philipp. Journ. Sci.*, IX, Sec. B, Tropical Medicine, pp. 49-80 (1914).

(6) Fæces mixed with water and sprinkled on grass infected 24 hours later.

(7) Fæces and urine mixed with water and kept in shade remained infective for 36 hours, but not longer.

(8) There was no evidence that recovered cases transmitted the disease.

(9) Virus is not harboured for long periods in contaminated soil.

(10) Therefore the virus of rinderpest perishes soon after being discharged by the infected animal.

Shilston's observations [1] on the viability of the virus would also appear to be, in the main, in accord with those of Ward and his collaborators, although, so far as the duration of its vitality in meat, bone marrow and blood was concerned, he found it to vary from 3 to 51 days.

In the case of the majority of diseases, in which insect vectors are supposed to be concerned, there does not appear to be on record much evidence of efforts having been made to correlate the epidemiological *data* with the ætiology of those diseases, in so far as such *data* are calculated to throw light on the probable character of the vectors concerned. The mere linking of the seasonal outbreak of a disease with the seasonal prevalence of an insect, can be but of little value, unless the question is viewed from an epidemiological standpoint, *i.e.*, unless the combination of all the circumstances under which an epidemic is found to occur, should point to a particular insect or a group of insects as being concerned in the propagation of the disease. This would require not only an intimate knowledge of the bionomics of the insect that is incriminated, but also a careful sifting of all ecological *data* relating to the question. For instance, Ashburn and Craig [2] advance the following grounds for suspecting mosquitos as the probable transmitters of dengue: "Its seasonal prevalence, its occurrence along low-lying, moist coast regions, and in the valleys of rivers, most frequently; its rapid diffusion in some localities, and its lack of diffusion in others; its relation to changes in temperature and moisture; its manner of spread from building to building in infected places; its absence in high altitudes where mosquitos are absent; the presence of multitudes of mosquitos wherever dengue occurs, and the absence of the disease in regions where mosquitos are absent or few in numbers, and the cessation of the epidemic in badly infected districts when conditions arise which are unfavourable to the propagation of mosquitos, all point to some species of this insect as the infecting agent." In the case of relapsing fevers, again, Todd [3] refers to the fact that these fevers are "characteristically seen in times of stress and where human beings are herded together in unsanitary surroundings." "Relapsing fevers," he says, "are among the plagues of armies. When relapsing fever occurs outside an endemic area, it usually appears in ships, in hotels, or in communities on lines of travel"; and all these facts point to lice as the probable transmitters, and the hypothesis has been borne

[1] *Mem. Dept. Agri. India, Vet. Ser.*, III, No. 1 (October 1917).
[2] *Journ. Infect. Dis.*, IV, pp. 464-465 (1907).
[3] Byam and Archibald. *The Practice of Medicine in the Tropics*, Vol. II, p. 1254 (1921).

out by experimental evidence. The recent observations on the kala-azar epidemic, particularly those of Knowles and his collaborators,[1] are equally instructive. They exclude lice, as the community concerned are not infested to any marked degree by these insects. Mosquitos and other flying hosts with a wide range of distribution are also excluded in view of the localized and household distribution of the disease. *Phlebotomus minutus* and *P. papatasii* are not suspected, as the two species occur all over India, but the distribution of *P. argentipes*, they state, corresponds with that of the disease. On the other hand, epidemiological evidence may sometimes point to a very unexpected conclusion. For instance, on epidemiological grounds, kala-azar in the Sudan was considered by Archibald to be transmitted, not by biting insects, but probably by "some intermediate host, whose habitat is in water."[2] Although, therefore, the results of bacteriological investigations may be calculated materially to help in building up a hypothesis as to the probable character of an insect vector, so far as entomological endeavours are concerned, it would seem expedient to direct them, as a preliminary step, towards compiling all epidemiological *data* bearing on the problem; otherwise, the trouble entailed by experimenting with a large number of species, on the mere chance of securing positive results, is likely to assume enormous proportions.

II. The cyclical transmission of pathogenic organisms: the intermediary host.

It is useful to remember that the mere fact that an insect can transmit a disease only after a length of time since it sucked infected blood, is not in itself indicative of the fact that the causative organism undergoes a developmental cycle within the invertebrate host, such as is understood by the term "metaxeny." Except in a few cases, such as those of *Plasmodium* and *Hæmoproteus*, where schizonts, sporozoites, etc., have been definitely observed, there does not appear to be on record unequivocal evidence that might justify one to interpret the conditions, under which a disease is transmitted by an insect, as indicating a "metaxenous" mode of transmission, and, under such conditions, the possibility of the insect functioning as a cultural medium for the ingested parasite to multiply, should not be overlooked. Noguchi takes the only correct position when he says in regard to the transmission of yellow fever by *A.* (*S.*) *argenteus*: "The term intermediary host, however, is not used here in the sense understood in the case of certain protozoan organisms, which require an extrinsic host in which to pass their life-cycle, but denotes that a certain length of time is necessary for multiplication of the organisms to such numbers that the mosquito may transmit enough to produce infection. From the biological and cultural properties of the organism this seems

[1] *Ind. Med. Gaz.*, LVIII, pp. 321-349 (1923).
[2] *Report of Adv. Committee for Trop. Dis. Research Fund for 1914*, p. 116 (1915). Cited by Fantham in *Ann. Trop. Med. & Parasit.*, IX, p. 347 (1915).

reasonable, though the possibility of a stage of development in the mosquito has not been excluded." [1] The results of Noguchi's experiments with *A.* (*S.*) *argenteus* tend to prove that the traditional view, that the mosquito can transmit yellow fever only after a length of at least 12 days since its infective feed, is no longer tenable,—a view about which Seidelin (1911) had already expressed his misgivings. A few more opinions may be quoted, as on a proper appreciation of the issues involved in the two conceptions will depend, to a large extent, when positive results, if any, may be expected to ensue in any series of transmission experiments, and on it will also depend the range of insects to be experimented with; since, in the case of a truly "metaxenous" mode of transmission, the interval between the ingestion of the parasite by the insect and the appearance of the disease in the normal animal bitten, would remain approximately constant, and, also, highly specialized environmental conditions being necessary for the parasite to complete its developmental cycle, the vectors are likely to be restricted to one or a few species of insects; on the other hand, if the insect functions only as a cultural medium for the parasites to multiply, positive results may ensue at any time during the progress of a transmission experiment, it being merely necessary that the parasites should be enough in number to produce the infection, and, consequently, the vectors are likely to extend over many species of insects. The following remark by Noguchi, however, would seem to imply the possibility that only *A.* (*S.*) *argenteus* may provide the necessary cultural medium for *L. icteroides*: "Whether or not *L. icteroides* can survive and multiply only in the body of *Stegomyia calopus* and not in other varieties or genera is yet to be determined."[2]

Swingle [3] would appear to tend to be platitudinous when he remarks, in connexion with *Trypanosoma lewisi*, "After several years of doubt and argument, rigid experiment and accurate observation have brought to definite knowledge the fact that certain invertebrates serve as true intermediary hosts for blood trypanosomes. By the last clause, I do not mean to convey the idea that the trypanosome necessarily passes through a sexual cycle within the invertebrate host. This much has been proved, that it establishes itself in the invertebrate in such a manner as to make possible for an indefinite period its introduction into its vertebrate host by the bite of the intermediary host. In other words, the cyclical method of transmission has been established. This does not annul the fact that the invertebrate may in addition act as a mere mechanical carrier."

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[1] *Journ. Exper. Med.*, XXX, p. 406 (1919).

[2] *Loc. cit.*, p. 410. *Cf.* Agramonte's observations in a recent paper in this connexion. He argues that in all known cases of insect-borne spirochætal diseases, "the insects act as simple vectors or carriers of the germ, while we have reason to believe that in yellow fever the parasite must undergo some kind of evolution in the mosquitos' tissue, just as the malarial parasites do in the anopheline." He further writes: "I have not heard of any one attempting to demonstrate an insectile evolution of *L. icteroides* in *Ædes aegypti*. An *enriching* process has been suggested, but that is only a hypothesis to explain the occasional success in the midst of many negative experiments. We know that no changes take place, and that the mosquito soon expels the leptospira just as it took it from the capillaries of the guinea-pig."—*Journ. Trop. Med. & Hyg.*, XXVII, p. 286 (Nov. 1, 1924).

[3] *Journ. Infect. Dis.*, VIII, p. 125 (1911).

That there is a general tendency to attribute only to such organisms, as bacilli, the property of multiplying within the invertebrate host (without undergoing a developmental cycle), is exemplified by the following quotation: "Another observation which has been especially puzzling to all investigators has been the fact that the lice seem only to become infective five to six or even ten days after the first feeding. Nicolle believed that this was evidence that the micro-organism is a protozoon, and that this length of time was needed for it to pass through some developmental cycle in the body of the louse, preliminary to becoming infective. Since the micro-organism is a bacillus, the only possible explanation is the one suggested originally by Ricketts and Wilder, that during the period the bacilli in the lice are undergoing an increase in numbers and virulence."[1]

The fact that in some cases the same disease has been proved to be transmitted by more than one species of insect and, in many cases, at various intervals of time, would seem to indicate that true metaxeny is rather the exception than the rule, although in the absence of actual demonstration, any hypothesis advanced in this connexion must be considered as *ex cathedrâ.*

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[1] Plotz, H., Olitsky, P. K., and Baehr, G. *Journ. Infect. Dis.*, XVII, p. 62 (1915).

PART I.

Transmission of Rinderpest by means of *Aëdes* (*Stegomyia*) *albopicta*, Skuse.

These experiments were suggested by certain bacteriological findings obtained by the Director of the Imperial Institute of Veterinary Research, Muktesar, in the course of his investigations upon the ætiology of rinderpest, which seemed to indicate that the causative organism of the disease was, in many of its characteristics, probably not unlike *Leptospira icteroides*, the spirochæte incriminated with the causation of yellow fever and known to be transmitted by *A.* (*S.*) *argenteus*; it seemed to him therefore that some further evidence concerning the nature of the virus of the cattle disease might be obtained by exploiting the apparent analogy with the human affection, and hence early in 1923 the Imperial Entomologist was approached with a view to deputing trained entomological assistance to elucidate certain possibilities in regard to vector transmission which had already been investigated by workers upon the ætiology of yellow fever.[1]

The experiments of this series were started by the Imperial Entomologist at Muktesar, about the last week of April 1923, and, on his departure from Muktesar, on 15th May 1923, were continued by the writer of this report until they were brought to a close on 28th October 1923.

Arthropods as vectors of spirochætes.

During recent years several workers have sought to attribute to spirochætes the pathogenic *rôle* in the causation of various diseases, supposed to be transmitted by insects. Several workers have suspected some species of *Leptospira* as the causative organism of dengue fever and, on epidemiological grounds, Chandler and Rice[2] consider *A.* (*S.*) *argenteus* as the probable transmitter of the disease. Transmission experiments were successful in four out of six cases. They conclude that this mosquito can transmit the disease, as it appeared in the Texas epidemic, in from 24 to at least 96 hours after biting a patient, and that it can become infected from patients in various stages of the disease from the first to at least the fifth day. At Braz-

[1] The results of bacteriological investigations, so far obtained, do not warrant a definite statement at this stage, and further work is in progress whilst this report is being written. Reference may, however, be made to the *Report of the Imperial Bacteriological Laboratory, Muktesar, for the two years ending the 31st March, 1924*, where the results of very extensive investigations upon the nature of the virus are summarized very briefly; they will be published soon as a memoir when they have been elaborated in certain particulars.

[2] *Amer. Journ. Trop. Med.*, III, pp. 233-262 (1923). [Abstract in *Rev. App. Entom.*, B, XI, p. 143 (1923).] In this connexion it is of interest that in the case of dengue, Harris and Duval have demonstrated structures culturally which are similar to those demonstrated by the Director of the Muktesar Institute. See *Journ. Exp Med.*, XL, pp. 817-833 (1924).

zaville, Blanchard and his collaborators [1] observed a form of spirochætosis which bore a close resemblance to infectious jaundice (of which the causative organism is *L. icterohæmorrhagiæ*). They obtained negative results with *Aëdes* (*Stegomyia*), but positive results with *Cimex lectularius,* some of the bugs remaining infective for 38 days. Whittingham,[2] in the case of sand-fly fever, isolated a species of *Leptospira*, indistinguishable from *L. icterohæmorrhagiæ*. Mention need hardly be made of *L. icteroides*, the causative agent of yellow fever, transmitted by *A.* (*S.*) *argenteus ; Spirochæta recurrentis* the causative agent of European relapsing fevers, transmitted by *Pediculus* and *S. duttoni* and *S. novyi*, the causative agents of African and American relapsing fevers, in which the vectors are ticks, notably *Ornithodorus moubata.*

The ætiology of yellow fever.[3]

Finlay (1883-1899) appears to have been the first definitely to set forward the theory that yellow fever is transmitted by *A.* (*S.*) *argenteus*. It was, however, the work of U. S. Army Commission (1901-1902), consisting of Reed, Agramonte, Carroll and Lazear, that was responsible for the general acceptance of the view that yellow fever was transmitted by mosquitos.

According to Carroll (1903) positive results were obtained in fourteen out of twenty-three cases, but evidently in few of the cases were typical results obtained, and this was accounted for by the fact that the patients had the advantage of good treatment, from the beginning of the disease. Positive results also attended the efforts of Guiteras (1901), of Marchoux, Salimbeni and Simond (1903), who composed the famous French Commission on yellow fever, and of others, fifteen positive cases being added, according to Carroll (1905), to the fourteen already obtained by the U. S. Army Commission, although the methods of experimentation employed by these workers, do not appear conclusively to prove that the disease might not have been contracted otherwise than by experimental inoculations.

Finlay (1886) claimed to have obtained positive results by inoculation two days after the mosquito had bitten a yellow fever patient, whereas Reed and his collaborators found an interval of at least 12 days necessary. The French Commission, as pointed out by Seidelin, although usually quoted as the authors of the twelve day doctrine, seem to have drawn their conclusion from the facts published by the American Commission and in their later papers Reed (1902) and Carroll (1905) do not draw any definite conclusion from their own observations, so that, as observed by Seidelin, "it is obvious that it is, at present, impossible to lay down any definite time-limit ; nevertheless, it is now everywhere in yellow fever literature taken for granted that the mosquito can only transmit yellow fever after a period of at least

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1 *Bull. Soc. Path. Exot.*, XVI, pp. 184-193 (1923).
2 *Proc. Roy. Soc. Med.*, XVI, pp. 1-14 (1922).
3 Many of the references in this section have been taken from Harald Seidelin's article entitled "The etiology of yellow fever" in *Yellow Fever Bureau Bulletin,* I, p. 229 *et seq.* (1911-12).

twelve days since it sucked infected blood; this is taken for granted, simply because it has been once said, though without any proof, and afterwards repeated again and again. The inference has been made next, and quite naturally, that the yellow fever parasite undergoes an evolution of twelve days' duration in the *Stegomyia fasciata*. This remains to be investigated."

The main conclusions arrived at by the French Commission were :—

1. The serum of a patient is virulent on the third day of the illness.
2. On the fourth day the blood of a yellow fever patient no longer contains the virus, even when the fever is higher.
3. One-tenth c.c. of virulent serum injected under the skin is sufficient to give the fever.
4. As proved by Reed, Carroll and Agramonte, yellow fever is produced by the puncture of *A.* (*S.*) *argenteus*.
5. To be able to produce the illness with man, the mosquito must be infected, previously, by absorbing the blood of a yellow fever patient during the first three days of the sickness.
6. The infected mosquito is dangerous only after an interval of at least 12 days after it has sucked virulent blood.
7. The punctures of two infected mosquitos may bring about a very severe case.
8. The mosquito appears to be more dangerous in proportion with the length of time which has elapsed after infection.
9. The puncture of infected mosquitos does not invariably give yellow fever.

The Commission was unable to find, either in the mosquito or in the blood, the causative organism of yellow fever. [1]

It is out of place in an entomological paper to refer exhaustively to the efforts made by various workers to discover the causative organism of yellow fever. A perusal of the history of the progress of this inquiry shows that the parasite has been identified, at one time or another, with almost every kind of micro-organism. Numerous bacilli and cocci have been described in the belief that they represented the causative organisms of the disease. Reviews of the corresponding literature are found in the treatises of Bérenger-Féraud (1890) and Azevedo sodré and Couto (1901). The causative organism was considered to be *Cryptococcus xanthogenes* by Freire (1885, 1898); *Bacillus icteroides* by Sanarelli (1897) and Bandi (1904). Various protozoan-like organisms have also been described as the pathogenic agents of yellow fever, by Klebs (1898), Lacerda (1893), Pothier, Hume, Watson and couret (1905), Schüller (1906) and Thayer (1907). Schüller observed schizonts and gametes and even spirochætoid forms, whilst Stimson (1907) observed a spirochæte in the sections of the kidney in a case of yellow fever. Seidelin also claimed the discovery of the

[1] ***Ann. Inst. Pasteur*, XVII, pp. 728-730. (1903).**

causative organism of yellow fever, which he considered to be a protozoon. The honour of discovering the actual parasite, however, was reserved for Noguchi, who, by his recent researches, has conclusively demonstrated that the causative organism is *L. icteroides*. A summary of Noguchi's results of transmission experiments is given below:

(*a*) *Transmission experiments with* A. (S.) argenteus *from man to animals.*

Expt. 1. Aug. 5, 1918. 40 engorged on a patient. Aug. 10. 16 females surviving; these fed on young normal guinea-pig. Negative.

Expt. 2. Aug. 15. 12 of the 16 mosquitos in the above experiment surviving. Aug. 28. 8 still surviving; these fed on normal guinea-pig. Positive. (Mosquitos had sucked patient on 3rd day of disease.)

Expt. 3. Aug. 5, 1918. 28 females engorged on 4th or 5th day of disease. Aug. 10. 12 surviving. Aug. 12. Mosquitos placed on normal guinea-pig; several killed by animal and several engorged. Negative. Aug. 28. Surviving females allowed to bite normal guinea-pig; temperature rose to 39·9°C. but returned to normal.

Expt. 4. Aug. 14, 1918, 4-15 P.M. A large number placed on arm, 2nd day of disease. 60 females fully engorged and put into another cage. Aug. 15. Another feeding on the same patient. Aug. 27. 29 surviving; these fed on normal guinea-pig. Doubtful (probably mild infection).

Expt. 5. Aug. 14, 1918, 5 P.M. Right arm of patient put into cage on 2nd day of disease. Of 50 mosquitos only 5 sucked within about 30 minutes. Aug. 15, noon. Feeding repeated; 32 females engorged immediately. Aug. 28, 10 A.M. 13 survive and fed on normal guinea-pig. Negative.

Expt. 6 Aug. 28, 1918, noon. 80 females engorged on a mild case. Sept. 11. 23 surviving and allowed to feed on normal guinea-pig. Negative.

(*b*) *Transmission from animal to animal.*

Expt. 7 Aug. 4, 1918. 50 females infected with blood of guinea-pig which had been infected with *L. icteroides* 6 days previously. Aug. 8. Mosquitos fed on another guinea-pig showing fever and albuminuria. Mosquitos which were used later in the experiment recorded below were allowed to bite normal guinea-pig on the 6th day after first feeding; only 5 females sucked blood. Negative.

Expt. 8. Aug. 16 (12 days after the first and 8 days after the second feeding). Two normal guinea-pigs placed in cage; one bitten by 19 mosquitos. Positive. The other bitten by nine other mosquitos on the same day. This guinea-pig remained well for 24 days and was then subjected to a second infection with the same strain of the organism on Sept. 7. It proved refractory to the infection.

Expt. 9 Mosquitos used in Expt. 8 were kept for another experiment, but within 5 days, only 8 of the 28 mosquitos survived. These were allowed to bite another normal guinea-pig on Aug. 21. Negative.

Expt. 10. Aug. 13, 1918. In this series 4 guinea-pigs infected at different stages of the disease, 6th, 7th, 8th and 9th days after the inoculation, all showing the symptoms, were used to infect the mosquitos in four separate cages. 142 engorged females in all were collected and put together in one cage for further experiments.

Aug. 21. 83 females surviving and these fed on normal guinea-pig. Death occurred within 13 days. Positive.

Expt. 11. To supplement the foregoing experiments, on Aug. 23, *i.e.*, 2 days later, the same mosquitos, 25 in all, were crushed in a mortar and emulsified with Ringer's solution. The emulsion was examined for *Leptospira* under the dark-field microscope and also smeared over the scarified surface of the skin of a normal guinea-pig. Occasional specimens of *Leptospira* were found in the emulsion after long search.

The guinea-pig came down with typical symptoms on Aug. 31, *i.e.*, 8 days after inoculation. In the liver and kidney *Leptospira* was demonstrated in small numbers under the dark-field microscope.

Expt. 12. Some of the mosquitos used in Expt. 10, which had caused positive transmission after 8 days, were kept for another work. As stated above, on Aug. 23, 25 were crushed. Subsequently most of the remaining females laid eggs, and some perished. On Aug. 28 only 13 females were left; these allowed to bite a normal guinea-pig on that date. Negative.

Expt. 13. Aug. 11, 1918, 11 A.M. An infected guinea-pig, showing typical symptoms, was placed in mosquito cage; 24 engorged females were collected and put into another cage. Aug. 14. 16 additional engorged females were also put into the cage. Aug. 21. Mosquitos fed on a normal guinea-pig. Probably a mild infection.

Conclusion. In the case of human beings a mosquito is said to transmit yellow fever after a period of at least 12 days since it has sucked infected blood, but in the case of the animals the period was only 8 days. This difference can be explained by the fact that the number of *Leptospira* in experimentally infected animals is far greater than in naturally infected human beings.[1]

I. Methods and material.

The selection of the invertebrate host.

Aëdes (*Stegomyia*) *albopicta* was the mosquito selected for these experiments on account of the great abundance of this species in India, and also in view of the fact that both in morphology and habits it is very like the yellow fever mosquito,

[1] *Journ. Exper. Med.*, XXX, pp. 404-409 (1919).

A. (*S.*) *argenteus.* As a matter of fact, Leishman even planned to carry out a series of experiments with *A.* (*S.*) *albopicta* in connexion with yellow fever.[1]

In none of the experiments were wild mosquitos used, all being bred out under laboratory conditions.

The place of experimentation.

Muktesar, the place where the experiments were carried out, is situated at an altitude of about 7,500 ft. The minimum and maximum temperature of the place during the summer months is given in Appendix II. The two great advantages of the place were the existence of a well-equipped laboratory and the presence of a large number of experimental animals, an experimentally inoculated animal being obtainable almost whenever required.

Kinghorn and Yorke,[2] in an article entitled "On the influence of meteorological conditions on the development of *Trypanosoma rhodesiense* in *Glossina morsitans*," write: "The developmental cycle of *T. rhodesiense* in *G. morsitans* is, to a marked degree, influenced by the temperature to which the flies are subjected. High temperatures (75°-85° F.) favour the development of the parasite, whilst low temperatures (60°-70° F.) are unfavourable." If this is also true of the spirochætes, then the parasites (if these belonged to that group) must have been at a disadvantage in the very low temperature of Muktesar.

The selection of the reservoir of virus.

For the initial feeds the mosquitos were allowed to bite bulls experimentally inoculated with the virus of rinderpest, such infected bulls being called "Controls."

It was somewhat difficult to come to a decision as to the best time for the mosquitos to take their initial feeds, during the progress of the disease in experimentally inoculated animals. Curasson (*loc. cit.*) removed his tick on the second day of the disease, but in view of the very inconclusive character of his results, it is not possible to say anything for or against his choice. Noguchi fed his mosquitos (*loc. cit.*) on from the second to the fifth day of the disease in human beings. Reed (1902) concludes from experiments with direct inoculation of blood that the specific agent of yellow fever is present in the blood at least during the first, second and third day of the attack. Marchoux, Salimbeni and Simond (1903) deduce a similar conclusion from their blood injection experiments. After very exhaustively considering the *data* from which these workers have drawn their conclusions, Seidelin remarks: "It can, consequently, not be considered proved that the blood of a yellow fever patient is infective during the first three days only; much less can it be concluded that the parasite must be absent from the blood after that time."

[1] White is of opinion that "it is possible that *Aëdes albopicta* (*scutellaris*) is a vector as well as *A. argenteus* (*ægypti*)." *A Folha Medica*, V, pp. 193-197 (1924). [Abstract in *Rev. App. Entom.*, B, XII, pp. 173-174 (1924).].

[2] *Ann. Trop. Med. & Parasit.*, VI, p. 412 (1912).

In the present series of experiments the time just prior to, or immediately following, the onset of vesicles on the buccal mucous membrane, was usually selected for the initial blood feeds, although in some cases this rule was not strictly adhered to.

The selection of experimental animals.

The normal bulls on which the infected mosquitos were fed were usually kept singly in small sheds, called "*chuppers.*" These sheds were situated fairly wide apart from one another, and at a considerable distance from the shed where the "Controls" were kept. In view of the preliminary character of the experiments aimed at, no attempt was made to protect the experimental animals from the bites of other insects.

O'Brien refers to a suggestion, made by Dr. Pareja of Guayaquil, that children are less susceptible to contract yellow fever than adults owing to the fact that the liver in children is larger in proportion to the body than is the case in adults, and "it may have some function or secretion absent in the adult, and which has the power of combating the yellow fever virus."[1] O'Brien remarks that "if this property of children is common to other young mammals, it might have its use either as a protective or as a curative agent."[o] The series of experiments recorded in this paper were, however, carried out on both adult and young animals.

The rearing of A. (S.) albopicta in high altitudes.

Tree-hole materials, containing *Stegomyia* eggs in desicated condition, were taken from Pusa, the materials being divided into two lots, labelled I and II. The first represented the comparatively loose and superficial débris, the second being obtained by scraping the sides and the deeper regions of the hole. As will be seen from the schedule of breeding experiments, the two lots differed considerably in the richness of materials (eggs).

Later on, the tree-hole materials taken from Pusa being exhausted, attempts had to be made to get eggs deposited in captivity at Muktesar, and the results of these attempts are also given in this paper.

As the very low temperature of Muktesar retarded the matamorphosis of the various stages and considerably delayed oviposition, the use of an incubator, kept at about 28° C., was afterwards resorted to.[2]

The tree-hole materials taken from Pusa, although yielding well-sized adults when treated with water did not appear to provide sufficient nutriment when used a second time for the larvæ that hatched out from eggs deposited in captivity at Muktesar, and therefore other sources of food had to be looked for.

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[1] *Ann. Trop. Med. & Parasit.*, VIII, p. 375 (1914-15). The Director of the Muktesar Institute also observes that recent experiences at Muktesar point to a greater resistance of the young animal towards rinderpest.

[2] 28°C. was the temperature chosen in view of the findings of the French Commission with regard to *A.* (S.) *argenteus*.

The uncertain nutritive value of various algæ and leaves (some of which might even be toxic to the larvæ), coupled with the difficulty of procuring Stegomyias at Muktesar, made it necessary to try only such food as had been tested and found satisfactory by previous workers.

Reed and Carroll and also the French Commission on yellow fever found that *A.* (*S.*) *argenteus* throve remarkably well in water containing fæcal matter, whilst Dupree and Morgan record that they found that it even hastened the development until the life-cycle was completed in from six to eight days. The French Commission also report having reared *argenteus* larvæ easily in water in which had been placed excremental pellets or grains of corn or wheat, alimentary débris and amylaceous and fatty material.[1]

Atkin and Bacot,[2] Fielding,[3] and Young[4] have tried a number of substances as foods for *Stegomyia* larvæ, and Fielding, particularly, has even carried out quantitative experiments, giving weighed quantities of the food-material to a known number of larvæ, in measured quantities of water. The materials which he tried were, principally, polished rice, dry cockroach and dry mango leaves. Blacklock[5] also recommends dry cockroach.

In feeding the larvæ of *A.* (*S.*) *albopicta*, particular attention was given to two substances, namely, rice grains and dry specimens of *Musca* sp.,[6] the latter being considered a good substitute for dry cockroach. The chief disadvantage of using rice grains—although otherwise they proved fairly satisfactory—was that, when left in water for a long time in the incubator, they became semi-boiled and showed tendency to ferment; the water smelt rancid and the larvæ did not thrive well under such conditions. Except for the fact that the dry specimens of *Musca* sp., would not sink readily in water—and the sinking was very necessary in view of the fact that *Stegomyia* larvæ are chiefly bottom-feeders—they answered well as food for the larvæ, and mortality was almost *nil.*

The method of keeping mosquitos and feeding them on animals.

A considerable mass of literature was gone through with a view to findin out a suitable method of keeping and feeding mosquitos and other biting files, but the various methods recommended appeared to be unsatisfactory in one way or another. One notices with surprise the perfunctory character of the methods employed by most

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[1] Howard, Dyar and Knab. *The Mosquitoes of North and Central America and West Indies,* Vol. I, p. 287 (1912).

[2] *Parasitology,* IX, pp. 482-536 (1917).

[3] *Ann. Trop. Med. & Parasit.,* XIII, pp. 259-296 (1919).

[4] *Ann. Trop. Med. & Parasit.,* XVI, pp. 389-406 (1922).

[5] *Ann. Trop. Med. & Parasit.,* XV, p. 476 (1921).

[6] Specimens of this species were very common in houses at Muktesar. It was curious to notice innumerable dead specimens hanging on walls and on the glass panes of doors and windows, during the summer and monsoon months at Muktesar. On examination it appeared that the flies attached themselves to those places by means of their proboscides, which, evidently, secreted a sticky material when the flies died. Most of the flies were presumably killed by the fungus *Empusamuscœ.*

workers in feeding insects in transmission experiments. The result has been that the validity of their conclusions has not only been questioned by critics, but the conclusions have frequently been half-heartedly upheld by the workers themselves. This state of affairs appears to be, to a large extent, due to the fact that an enormous amount of patience and trouble is required in maintaining and feeding insects at regular intervals of time and, to a partial extent, to the fact that, as many of these workers were *bonâ fide* bacteriologists or protozoologists, emphasis on those aspects which relate to their own special subjects, has resulted in summary work being done with regard to the entomological side of a question. Noguchi himself thus writes of his yellow fever transmission experiments : "Since an enormous amount of labour would be required to test the infectivity of each female mosquito, summary experiments were made ; that is, a dozen or more mosquitos were allowed to bite one and sometimes two animals at the same time" (*loc. cit.*, p. 404). Curasson (*loc. cit.*) remarks on his own experiments that as conditions with regard to isolation, during the experiments were not above suspicion, no great importance is attached to the positive results obtained. The same remarks apply to the yellow fever transmission experiments carried out by Finlay, Reed and others. Regarding the dengue fever transmission experiments, carried out by Guiteras and Cartaya, Guiteras himself remarks that the small number of the mosquitos and their lack of variety deprive the negative result of a claim to conclusive character.[1] Again, Agramonte, in spite of his failure to transmit dengue by means of mosquitos, states that "he believes that the mosquito transmits the disease, and that his negative results were due to some undiscovered fault in technique."[2]

In attempting to transmit *Trypanosoma gambiense* by various flies, Dutton and his collaborators kept them in cubical cages, eighteen inches along each side and containing water and growing grass, the cages being placed in sheltered position out of doors. At first the experimental animals were set free within the cages, but afterwards they were immobilized. "The method, however," as they confess, "had distinct disadvantages : it was difficult to feed the flies on large animals and, because of the size and contents of the cages, it was almost impossible to count the number of living flies they contained."[3] The method adopted by Kinghorn and Yorke[4] for feeding tsetse flies appears to have been sound in view of the protection it afforded against outside contamination. They enclosed the animals in fly-proof cages, the fronts of which were protected by a double layer of wire-gauze, the inner composed of coarse and the outer of mosquito meshing. The two layers were separated by a space of one inch in order to obviate the possibility of the animal being bitten while

[1] Cited by Ashburn and Craig in *Journ. Infect. Dis.*, IV, p. 442 (1907).

[2] Cited by Ashburn and Craig. *Ibid*, p. 442 (1907).

[3] *Ann. Trop. Med. & Parasit.*, I, p. 203 (1907-08). Amongst the insects they experimented with, were Anophelines and *Simulium*, but with regard to the latter, they write : "It was hoped to do a series of experiments with them, but they were found to be so difficult to manage that the idea was given up" (p. 215) ; some experiments with freshly caught specimens, however, gave negative results.

[4] *Ann. Trop. Med. & Parasit.*, VI, pp. 3-4 (1912).

pressing the body against the front of the cage. Each fly was preserved in a separate bottle and had special number, so that an exact history of its life, the number of meals it had, the animals on which it fed, and other particulars were available. As will be seen from what follows, a similar method was adopted for feeding *A* (*S.*) *albopicta*, although for obvious reasons the experimental bulls could not be kept in the way in which Kinghorn and Yorke kept their monkeys. In attempting to transmit poliomyelitis by the bite of *Lyperosia irritans*, Francis[1] used a big cage, the top of which was made of wire-gauze, over which the monkeys, after having been shaven on the belly and inside of the thighs, were kept stretched in order to allow the enclosed mosquitos to bite through the meshes of the wire-gauze, but he writes that " great difficulty was experienced in keeping the flies alive in captivity. If left unfed for twenty-four hours practically all of the flies die. It was found that frequent feeding on a live animal was necessary. The plan finally adopted was to allow them to bite a monkey every six hours." In the case of *Glossina palpalis*, Stuhlmann found that it was best to keep the flies singly or few together, otherwise they fouled one another with excreta. Therefore he used glasses, the mouths of which were covered with mosquito netting, through which the flies sucked. He recommends the use of blotting paper for lining the glasses in order that the excrement may be absorbed and the glasses be kept clean.[2] Mitzmain[3] made an effort to induce *Tabanus striatus* to feed on healthy and infected animals kept together in a large screened cage, but the results were negative, the flies dying in a few days when kept within the enclosure. Cross and Patel[4] kept their Tabanids in cloth cages over basins of water in such a way that the flies could suck moisture whenever they wanted ; the flies were taken out in small beakers for feeding, and placed back into the cage when the feeding was over.

With regard to the keeping and feeding of mosquitos in particular, Fielding[5] recommends a cloth cage to enclose the mosquitos; after the animal is immobilized, its head is inserted into the cage through a door in order to allow the mosquitos to bite, but he says that the feeding of mosquitos on small animals (*e.g.*, guinea-pigs) is, as a rule, unsuccessful. Ashburn and Craig[6] used mosquito-proof tents and mosquito bars for dengue fever transmission experiments with mosquitos. Stephens and Christophers[7] recommend keeping and feeding mosquitos in bottles. Leese,[8] who used wild mosquitos, recommends feeding them singly in tubes, as otherwise it is frequently difficult to vouschafe that a mosquito has actually bitten. Patton and Cragg[9] recommend feeding them in bottles, and, in the case

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[1] *Journ. Infect. Dis.*, XV, pp. 1-5, fig. 2 (1914).
[2] *Bull. Sleeping sickness Bureau*, I, p. 93 (1908).
[3] *Philipp. Journ. Sci.*, Sec. B, VIII, p. 226 (1913).
[4] *Dept. Agric. Punjab Vet. Bull.*, No. 5 (1921).
[5] *Ann. Trop. Med. & Parasit.*, XIII, pp. 260-261 (1919).
[6] *Journ. Infect. Dis.*, IV, p. 466 (1907).
[7] *The Practical Study of Malaria and other Blood Parasites*, pp. 93-94 (1908).
[8] " Experiments regarding the natural transmission of surra carried out at Mohand in 1908," *Ind. Civil Vet. Dept. Mem.*, No. 2, p. 15 (n.d.).
[9] *A Text-book of Medical Entomology*, pp. 269-270 (1913).

of mosquitos that will not feed under such conditions, they suggest the use of mosquito curtains. Price[1] gives a very detailed description and illustration of a cage which he used with success for rearing and keeping mosquitos its special feature being the adjustability of its component parts and it was provided with a movable glass top with a door for the insertion of the hand. Darling[2] considers that ordinary glass chimneys, covered at both ends with netting, are suitable both for keeping and feeding mosquitos. Pressat[3] used an elaborate cage the chief feature of which was a metallic chimney into which was fitted a removable glass tube. In order to take out the mosquitos, disturbance was caused amongst them by means of a sort of small broom-stick ("chasse-mouches en fibres de palmier") and the mosquitos were thus made to enter the glass tube, which was then removed. Blacklock[4] recommends for the larvæ the use of small tubes provided with special lids, the tubes being placed in a row in grooves cut into a wooden platform. Noguchi's cage consisted of a wooden frame with a wire net on all but two opposing walls, which were solid pieces of wood with round opening in the centre for the insertion of the arm or a glass of water. The opening was closed by a well-fitting door which could be drawn to one side and slipped back in place. A long glass cylinder about 8 inches long and 2 inches in diameter with one end closed was used for handling individual mosquitos (*loc. cit.*, p. 402).

It is outside the scope of the present paper to enter into a detailed consideration of the methods enumerated above, but they may be briefly dealt with, inasmuch as on the nature of the technique employed depends, to a large measure, the success in transmission experiments.

In the first place, the method to be adopted will depend on whether it is intended to feed the insects in batches or singly. In either case it is essential that a large number of insects should be fed, in view of the fact that in the majority of insect-borne diseases, only a small percentage of the insects fed on infected animals becomes infective.[5] For example, Kinghorn and Yorke[6] found that only about 5 per cent. of tsetse flies (*Glossina morsitans*) became infected when fed on animals harbouring the trypanosomes. Bruce[7] found the percentage to be only

[1] *Journ. Infect. Dis.*, supplement No. 3, pp. 123-127, fig. 1 (May 1907).

[2] Patton and Cragg. *Loc. cit.*, p. 269.

[3] *Le Paludisme et les Moustiques*, pp. 79-81, f. 4 (1905).

[4] *Ann. Trop. Med. & Parasit.*, XV, pp. 473-477 (1921).

[5] This is considered by some to be due to the ingested parasite not being able to adapt itself to the conditions furnished by the alimentary system of all the individuals of a species of insect; in other words, there is what may be called individual adaptability. Schaudinn considers that this may be due to (1) the insect itself suffering from some infection; (2) inability to digest the ingested blood; (3) an acquired or natural immunity resulting in the death of the specific parasite. [Cited by Ashburn and Craig. *Journ. Infect. Dis.*, IV, p. 468 (1907).] In the case of *A.* (*S.*) *argenteus*, Noguchi argues as follows: "A female *Stegomyia* may take up 0·01 c.c. of blood or even less. Apparently a mosquito occasionally becomes infectious by taking up the one or two organisms which happen to be circulating in the peripheral blood of man, and it is these occasionally infected few which carry the disease" (*loc. cit.*, p. 409).

[6] *Ann. Trop. Med. & Parasit.*, VI, p. 22 (1912).

[7] The Croonian lectures on trypanosomes causing disease in man and domestic animals in Central Africa. *Lancet*, p. 5 (July 3, 1915).

0·2 in the case of *G. morsitans* caught in areas infected with *T. brucei*. Robertson[1] found that 3 to 15·5 per cent. of *Glossina palpalis* became infective when fed on animals harbouring *T. gambiense*. Minchin and Thomson[2] state that about 26 per cent. of their fleas was infected with swarming *T. lewisi*. The French Commission on yellow fever remark: "The puncture of infected mosquitos does not always give yellow fever." Noguchi obtained positive results in only 1 in 6 of his experiments, about 30 to 80 mosquitos being used in each experiment.

Massive feeding need only be resorted to when it is definitely intended that a large number of infected insects should *simultaneously* bite the experimental animal; in other words, when infection is considered to depend on the number of parasites injected into the vertebrate host at a given time; for example, Wilder[3] states that in the case of typhus fever "the minimum number of lice found necessary to infect a monkey was 17." Otherwise, although a considerable saving in time may be effected if insects are fed *en masse*, the disadvantages of such feeding are numerous, especially if it is necessary to carry on a large number of feedings at short intervals of time, with the same series of insects. The following are the chief disadvantages of feeding mosquitos in batches, in bottles, at short intervals of time:—

1. There is absolutely no means of knowing the number of times any particular mosquito has fed. Since it is considered that only a small percentage of infected insects can become infective, it is essential to know whether a sufficient number of mosquitos has bitten, in order that a percentage may be worked out.

2. In attempting to bring a particular unfed mosquito to a desired position (*e.g.*, by tapping the bottle), violence is unavoidably applied on those that have fed.

3. When several mosquitos freely move about in a bottle, it is frequently difficult to ascertain how many of them have actually taken their feeds.

4. It is not convenient to feed the mosquitos with foods other than blood, *e.g.*, raisins, bananas, sugar, etc.

5. It was repeatedly observed that even when the enclosed mosquitos had been made to settle on the muslin cover of the tube, they left the muslin immediately the bottle was brought in contact with the skin of the animal. This appeared principally to be due to the sudden difference in illumination caused by the neck of the bottle forming a shadow on the muslin. In a thin-walled, narrow, straight glass tube (in which, however, more than one mosquito can hardly be comfortably accommodated), there is hardly any appreciable difference between outside and inside illumination when the tube is brought in contact with the skin of the animal.

6. It is extremely difficult to control the mosquitos, which usually lie scattered about in the bottle, frequently sheltering behind the piece of cardboard that is kept within the bottle for the mosquitos to rest upon.

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[1] *Phil. Trans. Roy. Soc.*, Ser. B, CCIII, p. 161 *et seq* (1913). [Cited by Hoare in *Parasitology*, XV, p. 413 (1923).]

[2] *Quart. Journ. Micro. Sci.*, LX, p. 485 (1915).

[3] *Journ. Infect. Dis.*, IX, p. 92 (1911).

Wire-gauze or cloth cages have the following disadvantages, in addition to some of the ones enumerated above :—

(1) It is almost impossible to bring any kind of physical pressure to bear upon the mosquitos in order to make them bite, unless one has recourse to contrivances of the kind of Pressat's cumbrous "chasse-mouches."

(2) They are not suitable for feeding on large animals, such as bulls.

(3) If the insects are frequently taken out of the cages for feeding, their liability to injury is considerable and the chances of their escaping are many. Their liability to injury is obvious if the experimental animal is placed within the cage. Several of Noguchi's mosquitos were killed by the guinea-pig moving about in the cage (*vide* his Expt. 3 *ante*).

After numerous trials the final method adopted for keeping the mosquitos was to enclose them singly in 30c.c. Nessler tubes (Fig. 1), each mosquito being numbered, so that a complete record of its history could be maintained, from the date of its emergence till its death.

During the earlier part of the work, moisture was supplied to the mosquitos by keeping the tubes, containing them, inverted over a wet piece of muslin, spread on the bottom of a large beaker. But the disadvantage of this method was that the muslin of the tubes always remained wet, and this evidently caused discomfort to the enclosed mosquitos, which were frequently seen brushing the moisture off their legs or cleaning their sodden wings. Later on, therefore, a piece of wire-gauze was placed over the muslin, in order to prevent the tubes from coming in actual contact with the moist muslin (Fig. 7). It appeared, however, that even under such conditions the mosquitos did not look happy and mortality was rather high, and this appeared chiefly to be due to the fact that the incessantly emanating effluvium from the moist muslin had a deleterious effect on the mosquitos. This fact, coupled with the obvious inconvenience of carrying about the tubes from *chupper* to *chupper*, caused the apparatus, shown in Fig. 8, to be improvised. It consisted of a cubical wooden box, provided with a perforated sheet of wood (Fig. 8*b*) and a zinc tray (Fig. 8*c*). The zinc tray was designed to contain the moist muslin and was provided with a wire-gauze lid (Fig. 8*d*). The tray could be taken out, through a small door at the bottom of the box (as shown), whenever it was necessary to replenish the moisture. The box was designed to accommodate 25 Nessler tubes. A special advantage of such a box was that, being made water-tight, it afforded sufficient protection to the mosquitos against getting wet while being carried about from *chupper* to *chupper*, during the heavy rains of the monsoon months.

It has been recorded that a netting of at least 18 meshes to the linear inch is necessary to prevent *A.* (*S.*) *argenteus* from escaping.[5] With regard to *A.*(*S.*) *albopicta*, numerous trials were given to an assorted series of netting with a view to finding

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[5] *Vide* chapter on yellow fever by Carter, in Byam and Archibald's *The Practice of Medicine in the Tropics*, Vol. II, p 1250 (1921); also, Vol. I, p. 27 (where, however, it is stated that a mesh of at least 16 holes to the linear inch should be chosen).

EXPLANATION OF PLATE XV.

FIG. 1. Nessler tube for keeping and feeding mosquitos.

FIG. 2. Tying up raisin on to muslin.

FIG. 3. Raisin as kept tied up inside Nessler tube : view of interior.

FIG. 4. Raisin as kept tied up inside Nessler tube : view of exterior.

The place where the raisin is tied up is shown by the arrow-head.

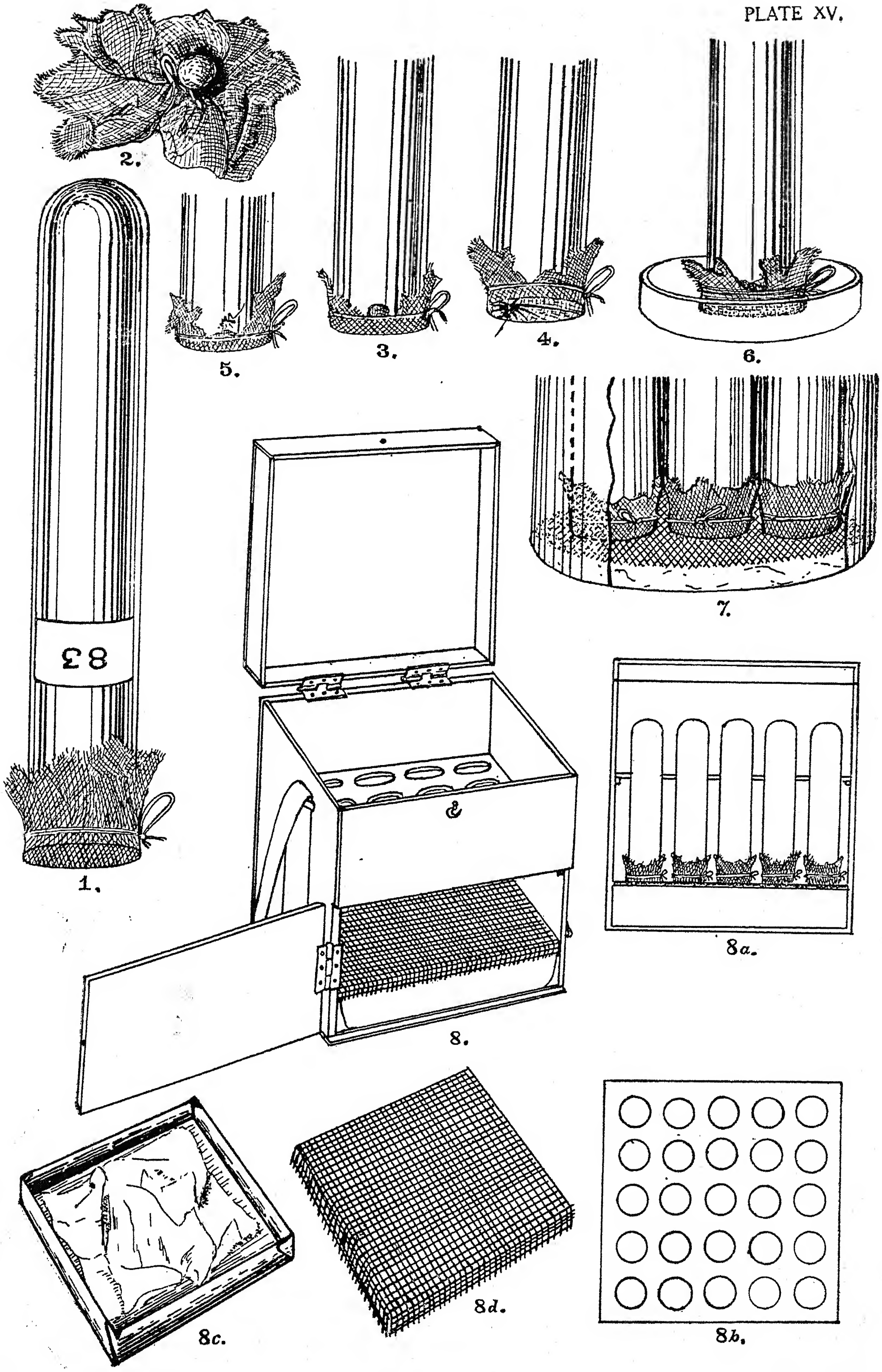
FIG. 5. Shows the manner in which the muslin gets drawn inside the tube as a result of the muslin being continually pressed against the skin of the animal during feeding work, so that the skin is hardly within the reach of the mosquito's proboscis.

FIG. 6. Feeding mosquito on sugar-solution.

FIG. 7. Keeping Nessler tubes (containing mosquitos) in beaker.

Fig. 8. Box for holding Nessler tubes containing mosquitos :

a, vertical section of box ; *b*, perforated sheet of wood ; *c*, zinc tray with muslin spread on bottom ; *d*, wire-gauze lid for zinc tray.



Showing method of keeping and feeding mosquitos.
(Rinderpest Transmission Experiments)

out the one most suitable for this kind of work. Through the courtesy of the Director of the Imperial Institute of Veterinary Research, inquiries were made both locally and in Calcutta for netting of the requisite grade. It was repeatedly observed that even gorged individuals of *A.* (*S.*) *albopicta* easily escaped through netting, about 13 meshes to the linear inch, such as is ordinarily used for mosquito curtains; and as no finer netting could be procured, the use of muslin had to be resorted to; and here again, repeated trials brought out the fact that, for successful work, it was not enough if the muslin were of the requisite meshing, but it appeared to be necessary to give particular attention to the grade of the thread used; for the disadvantage of thick or loosely spun threads (such as are used in the stuff locally known as *gara* or *khaddar*) is not only that they do not dry sufficiently quickly, when, for instance, the muslin has received a dipping in sugar solution, but, also, that it is frequently difficult to keep the muslin stretched to the extent necessary to ensure successful feeding. This is further discussed later on.

At first, the mosquitos were given meals of sugar solution for their initial feeds and also between feeds of blood. A thin layer of a concentrated solution of sugar was spread in a petri dish and the enclosed mosquitos were brought in contact with the sweet liquid (Fig. 6), when they sucked very readily through the meshes of the muslin. A few dippings in clean water generally removed any trace of the sugar solution that adhered to the mouth-region of the tubes or to their muslin coverings, and, except for occasional discomfort caused by minute quantities of the sugar solution sticking on to the legs (and sometimes to the wings) of the mosquitos, they seemed to remain usually otherwise uninjured. In view, however, of the obvious disadvantages of this method and of the possibility of the cane sugar having a deleterious effect on *Leptospira*, sugar was substituted by raisins, which were tied on to the muslin and offered to the mosquitos in the manner shown in figures. When it was intended to induce a mosquito to bite without removing the raisin, the latter was usually tied close to the wall of the tube, in order that a sufficient area might be left in the muslin on one side for the mosquito to settle upon (Fig. 4).

In the actual work of feeding the mosquitos on bulls, it was repeatedly brought out that the forcible establishment of contact between the mosquito and the skin of the animal was the first condition on which quick and successful feeding depended; for, if the mosquito was away from the muslin, it would seldom migrate of its own accord towards the muslin in order to bite. To induce the mosquito to settle on the muslin, the most effective plan appeared to be to turn the mouth-end of the tube towards the light when the mosquito readily settled on the muslin; if it did not move readily, a few smart strokes on the tube were usually enough to make it do so. It is obvious that for this purpose the most convenient plan would be to admit light from one direction only (preferably from the left) into the room in which the feeding is done. Feeding work done in the open, or in rooms equally illuminated on all sides, was, as a rule, unsuccessful.

Mention must also be made of the necessity of keeping the muslin of the tube as fully stretched as possible by tightly securing it with several turns of a twine. it was frequently observed that, as a result of constant pressure against the body of the animal, the muslin got loosened, its central portion being drawn inside the tube (Fig. 5), with the result that the proboscis of the mosquito could hardly reach the skin of the animal.

Finally, for feeding on bulls—a work requiring extremely arduous and sustained efforts—the necessity of adequately immobilizing the animal need hardly be emphasized. For this the best plan appeared to be to throw down the animal and secure it by tying up the legs with as many turns of a strong rope as possible. Failure to pay adequate attention to this important detail caused the writer many a bitter experience, especially when the animal happened to be a refractory one.

Several workers have referred to the difficulty of inducing insects to bite. Sergent and his collaborators [1] were compelled to content themselves by applying on scarified skin extracts of crushed *Phlebotomus*, having failed to induce these insects to bite. Baldrey[2] states, in connexion with his experiments with *Tabanus* and *Stomoxys*, at Muktesar, that he found it difficult to induce the insects to feed often. Stephens and Christophers (*loc. cit.*, p. 94) recommend moistening the skin of the animal with water in order to induce mosquitos to bite, whilst Connal and Connal[3] found that, in the case of *Chrysops*, moistening the skin of the animal with a drop of sugar solution was effective. The application of simple moisture or of sugar solution did not, however, seem appreciably to influence the biting propensities of *A.* (*S.*) *albopicta*. It appeared, however, that a mosquito would not usually take its first blood feed, unless previously fed on some sweet substance; but for the subsequent feeds of blood, the maintenance of contact of the mosquito with the skin of the animal was found to be all that was necessary, if the mosquito would feed at all.

Although it was usually easy to mark off an engorged mosquito, it was not always easy to trace the imbibed blood in the case of a mosquito which had fed slightly, or a mosquito whose previously ingested food had not been assimilated, or one which had not voided the thick pabulum that usually remains within the abdomen for some time, apparently after the work of assimilation is over. In all such cases a very careful examination with the lens was found necessary, and when blood was detected, it was generally found in the anterior end of the gut. It is obvious that accurate observations of this kind would have been hardly possible if the mosquitos were kept in batches in cloth cages or bottles, and, under such conditions, one would necessarily content oneself by following the method adopted by Bruce and his collaborators in the case of tsetse flies,[4] namely, to reckon only those as having fed, which fill themselves.

[1] *C. R. Acad. Sci.*, CLXXIII, pp. 1030-1032 (1921).
[2] *Journ. Trop. Vet. Sci.*, VI, p. 271 (1911-12).
[3] *Trans. Roy. Soc. Med. & Hyg.*, XVI, pp. 64-89 (1922).
[4] *Bull. Sleeping Sickness Bureau*, I, p. 179 (1909).

The main observations with regard to the feeding habits of *A.* (*S.*) *albopicta* may be summarized as follows :—

1. Contact with the skin of the animal generally furnished the necessary stimulus to the mosquito to bite.

2. Puncturing was not necessarily followed by the drawing of blood. Frequently, a mosquito was seen to stab the skin of the animal or even to keep its proboscis buried therein for a length of time, but careful examination did not reveal any trace of blood in its alimentary canal.

3. A mosquito would bite irrespective of the fact when it had had its last feed,[1] and the extent to which its abdomen was distended was not found to be the criterion of the avidity with which it would feed.

4. Individuals kept without food for a long time showed much reluctance to bite,—a fact which was contrary to expectation.

5. Striking results were obtained when, instead of persisting in one continuous attempt to feed a mosquito, the attempt was repeated at short intervals of time.

6. If interrupted during its first feed, a mosquito usually fed readily when tried a second time immediately after.

7. From the manner in which a mosquito sometimes behaved just prior to the act of biting, it seemed that its sense of vision hardly played any part in enabling it to locate its host. It was frequently observed (*e.g.*, in the case of Mosquito 18), when trying a mosquito on rabbits, that, in spite of the fact that its contact with the animal had been established, it went on moving its proboscis along the edges of the tube as if in search of something, until it (the proboscis) chanced to touch the skin of the animal.[2]

8. Rabbits seemed to be bitten much more readily than bulls.

9. A mosquito sometimes took a full feed only a few hours before death.

10. Permanent mutilation, such as the loss of a leg or a wing, or the presence of adhesive substances like sugar solution, or of even simple moisture, on the legs or wings, *i.e.*, whatever stood in the way of unobstructed locomotion, materially interfered with the biting of *A.* (*S.*) *albopicta*. On the other hand, mosquitos completely deprived of the power of locomotion or otherwise seriously injured, were found, although on rare occasions, to be capable of taking full feeds (*e.g.*, in the case of Mosquito 5 fed on bulls), when kept in prolonged contact with the skin of the animal.

11. Even at as low a temperature as 13°C., mosquitos sometimes bit as soon as their contact with the animal had been established. This observation is of some importance in view of the statements made by various workers with regard to the

[1] It should be mentioned that the interval that was allowed to pass between two feeds was never less than 24 hours.

[2] This seems to support the conclusion arrived at by O'Hea with regard to what he calls the " tactile vision " of insects. (*Nature*, No. 2789, p. 498; April 14, 1923. Also, his article entitled " Vision and light sensitiveness," *Nature*, No. 2795, p. 705; May 26, 1923.)

biting propensities of *A.(S.) argenteus*. For example, the French Commission found that *A.(S.) argenteus* became sluggish and would not bite at a temperature below 15°C., and that, at temperatures of from 14°C. to 18°C., it refused to bite when placed in contact with the skin, and that, under such conditions, it would bite only when the temperature inside the tubes was raised by the heat of the hand. Reed and Carroll found 62°F. (15·5°C.) to be the minimum temperature at which *A.(S.) argenteus* would bite. In the course of the present series of experiments it was brought out that its contact with the skin of the animal usually enabled the mosquito to overcome its torpidity caused by a prolonged exposure to a low atmospheric temperature, provided, of course, it had not been rendered moribund thereby.

12. Confinement in incubator (kept at 28°C.) for 24 hours or more, prior to feeding, did not appear to influence the biting propensities of *A.(S.) albopicta*, since, although showing considerable activity so long as kept in the incubator, the mosquitos became sluggish as soon as they were brought out and exposed to the low atmospheric temperature.

13. [1]No discrimination could be made as to the degree of readiness with which *A.(S.) albopicta* would bite between 9 A.M. and 5 P.M., during the months June to October (attempts to feed them at night were not made), and the hour at which it would feed did not seem to bear any relation to its age. These observations are of some interest in view of the experiences of various workers with *A.(S.) argenteus*. For example, Durham found that the time of chief activity of the mosquito was in the middle of the day, from about 12 noon to 2 P.M. Dutton observed that *A.(S.) argenteus* bit more especially in the early part of the afternoon, and, according to Hinds, *A.(S.) argenteus* is more active from 8 to 10 in the morning and from 4 to 6 in the afternoon. The French Commission observed that "when the female has reached a certain age, at the most two weeks, it will under no circumstances bite in the day time".[2] Carter's observations seem to be in accord with those of the writer, namely, that the biting depends more on the degree of the light than on the time of the day.

The inoculation of bulls with the bodies of infected mosquitos.

For purposes of inoculation most workers crushed their insects in some sort of liquid. Olitsky[3] and his collaborators prepared their lice for injection by crushing them in salt solution placed into sterile mortar, until a homogeneous emulsion was obtained. Curasson (*ante*) also crushed his insects and ticks in salt solution, whilst Noguchi crushed his mosquitos in Ringer's solutoin and applied the emulsion

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[1] The references in this paragraph have been compiled from Howard, Dyar and Knab's *The Mosquitoes of North and Central America and the West Indies*, Vol. I (1912).

[2] This view of the French Commission has, however, been subsequently refuted by more than one worker.

[3] *Journ. Infect. Dis.*, XIX, p. 826 (1916).

on the scarified surface of the skin of guinea-pigs. Most other workers crushed their insects in salt solution. As it was found that dilution considerably interfered with the virulence of the rinderpest virus, the mosquitos in the present series of experiments were always inoculated into the animals under dry conditions. At first, whole uncrushed mosquitos were inserted, under sterile precautions, into incisions cut into the skin of susceptible bulls, the incisions being afterwards stitched up. Later on, crushing being considered necessary to facilitate the emergence of any ingested parasites, the mosquitos were crushed dry on sterilized knife-blades, prior to inoculation.[1] The factors that tend to vitiate the results of such inoculation experiments are, however, several. For example, as suggested by the Director of the Imperial Institute of Veterinary Research, there might be pyogenic organisms present, and the parasites might be phagocyted at the site of injection.

The dissection of the internal parts of infected mosquitos and their examination for spirochætes.

Noguchi does not appear to have examined the internal parts of the infected mosquitos for *Leptospira* (although he examined crushed mosquitos), and he seems to base his conclusions on circumstantial evidence when he writes, "The comparatively aseptic body cavity of the Stegomyia furnishes a secure shelter for the parasite, which undoubtedly penetrates the zone of safety as soon as it is taken into the stomach of the insect. Unlike many other parasites this organism is capable of penetrating the intact skin or bacteria-proof filter and hence it is probably an easy matter for it to pierce the tissue of the visceral organs" (*loc. cit.*, p. 410).

As in the present series of experiments none of the mosquitos became infective, it appeared reasonable to assume that if any parasites were ingested, they did not find their way into the hæmocœlic fluid and invade the salivary glands, or even if they did, they were considerably attenuated. In view of these considerations and also of the findings of previous workers, and particularly in view of the fact that the mosquitos were dissected shortly after their infective feeds, only the alimentary tract was especially examined for the parasites.

In the case of the few microscopic examinations that were made of the gut-contents of *A.*(*S.*) *albopicta*, the specimen was first killed with chloroform and, after its wings and legs had been snipped off, the specimen was placed in a drop of normal saline and its intestines were pulled out through the penultimate segment, by applying as slight traction as possible to avoid injury to the gut. The thin gut-wall was next carefully punctured with the point of a fine sterile pipette, which also drew in a minute quantity of the contents and these were now placed on a slide and quickly covered over with a cover-slip, the edges of the cover-slip being vase-

[1] These operations were carried out by the Director of the Imperial Institute of Veterinary Research.

lined to prevent evaporation. The preparation was then examined by the dark-ground illumination method.[1]

II. Schedule of experiments.

The feeding experiments on bulls.

N.B. The following observations have been transcribed from the notes as originally recorded.

In view of the supposed existence of a correlation between the biting propensities of *Stegomyia* and the degree of illumination, the condition of the weather has been indicated whenever this has been noted. "Light changing" means that there was an alternation of light and shade owing to uncertain weather while the feeding work was being carried on.

Mosquito 1.

27-V. Found emerged. Enclosed in a cloth cage with several other males and females.

28-V. Removed from cage and enclosed in tube. Tried on Control 2076; did not bite. Fed on sugar solution.

29-V, 11 A.M. Tried on Control 2076; did not bite. Introduced 2 males into the tube.

30-V, 9 A.M. Tried on Control 2080; bit within 4 minutes of application. Males found dead.

31-V. Mosquito happy.

1-VI, 10 A.M. Tried on Bull 2222 in chupper 52; did not bite.
3 P.M. Fed on sugar solution.

2-VI, 10 A.M. Tried on Bull 2222 in chupper 52; did not bite.

3-VI, 9-30 A.M. Tried on Bull 2224 in chupper 53; did not bite. Mosquito very sluggish.
5-30 P.M. Fed on sugar solution.

4-VI, 6 P.M. Fed on sugar solution.

5-VI, 9-15 A.M. Tried on Bull 2223 in chupper 54; did not bite.

7-VI, 10 A.M. Tried on Bull 2245 in chupper 51; did not bite.

9-VI, 10-15 A.M. Tried on Bull 2241 in chupper 22; bit.

11-VI, 10 A.M. Tried on Bull 2243 in chupper 24; did not bite.

13-VI, 10 A.M. Tried on Bull 2240 in chupper 26; did not bite.

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[1] The writer desires to acknowledge his indebtedness to J. T. Edwards, Esq., Director of the Imperial Institute of Veterinary Research, for teaching him the technique of preparing such slides and the method of examining them dark-ground.

15-VI, 10-30 A.M. Tried for a very long time on Bull 2246 in chupper 29 ; did not bite.
17-VI, 9-30 A.M. Tried for a long time on Bull 2242 in chupper 30 ; did not bite.
19-VI, 10-30 A.M. Tried on Bull 2244 in chupper 32 ; did not bite. Mosquito moribund.
20-VI, 6 P.M. Mosquito moribund.
21-VI. Mosquito dead.

Mosquito 2.

31-V, 10 A.M. Found emerged. Tried on Control 2082 ; did not bite.
11 A.M. Fed on sugar solution.
1-VI, noon. Tried on Control 2079 ; did not bite.
3 P.M. Tried again on Control 2079 ; succeeded, after repeated attempts, in making it bite.
3-VI, 10 A.M. Tried on Bull 2222 in chupper 52 ; did not bite.
5-30 P.M. Fed on sugar solution.
4-VI, 6 P.M. Fed on sugar solution.
5-VI, 9-15 A.M. Tried on Bull 2224 in chupper 53 ; bit within 2 minutes of application. No feed of sugar solution to-day.
7-VI, 10 A.M. Tried on Bull 2223 in chupper 54 ; did not bite.
8-VI, 6 P.M. Offered sugar solution, but it did not feed.
9-VI, 10 A.M. Tried on Bull 2245 in chupper 51 ; bit.
11-VI, 10 A.M. Tried on Bull 2241 in chupper 22 ; did not bite.
13-VI, 10-30 A.M. Tried on Bull 2243 in chupper 24 ; succeeded, after repeated efforts, in making it bite. It took a very full feed.
15-VI, 10-15 A.M. Mosquito moribund.
6 P.M. Mosquito slightly revived and sucked a little of sugar solution.
16-VI, 6 P.M. Mosquito dead.

Mosquito 3.

31-V, 10 A.M. Found emerged. Tried on Control 2082 ; did not bite. Fed on sugar solution.
3 P.M. Mosquito escaped through netting.

Mosquito 4.

31-V, 10 A.M. Found emerged. Tried on Control 2079 at noon ; did not bite.
1-VI, 3-30 P.M. Fed on sugar solution.
2-VI, 3 P.M. Tried on Control 2085 ; did not bite. Mosquito moribund.

Mosquito 5.

30-V. Found emerged. Enclosed with 5 more females and 2 males in a bottle, which was kept inverted over its lid, a quantity of sugar solution and a few sheets of filter paper being placed in the cavity of the lid.

31-V, 10 A.M. Tried on Control 2082; did not bite. Sugar solution substituted by plain water.

noon. Tried again on Control 2082; did not bite.

3 P.M. Tried again on Control 2082; 3 engorged, of which one was enclosed in tube as No. 5, another as No. 6, while the third effected its escape through the netting, the unfed ones (3 females and one male) being enclosed together in bottle as No. 7.

2-VI, 10 A.M. Tried on Bull 2222 in chupper 52; did not bite.

3-VI, 5-30 P.M. Fed on sugar solution.

4-VI, 10 A.M. Tried on Bull 2224 in chupper 53; did not bite.

6 P.M. Fed on sugar solution.

6-VI, 10-30 A.M. Tried on Bull 2223 in chupper 54; succeeded, after repeated attempts, in making it bite. Was not fed on sugar solution to-day.

8-VI, 10-15 A.M. Tried on Bull 2245 in chupper 51; did not bite. Offered sugar solution, but it did not feed.

10-VI, 11 A.M. Tried on Bull 2241 in chupper 22; did not bite.

12-VI, noon. Tried for a long time on Bull 2243 in chupper 24; did not bite.

14-VI, 11 A.M. Tried repeatedly on Bull 2240 in chupper 26; did not bite.

16-VI, 9-30 A.M. Tried repeatedly on Bull 2246 in chupper 29; did not bite.

18-VI, 9-30 A.M. Tried repeatedly on Bull 2242 in chupper 30; bit.

20-VI, 11 A.M. Tried on Bull 2244 in chupper 32; bit fairly readily.

22-VI, noon. Tried on Bull 2348 in chupper 39; did not bite, although seemed attempting to puncture. Bull somewhat old.

24-VI. Not tried.

26-VI, 1-15 P.M. Tried on Bull 2349 in chupper 42 for a long time; did not bite, although made efforts to puncture. Bull old.

28-VI, 12-30 P.M. Tried on Bull 2351 in chupper 43; bit readily.

30-VI, 12-30 P.M. Tried on Bull 2347 in chupper 45; bit.

4-VII, 10 A.M. Tried for 1½ hours on Bull 2440 in chupper 52; bit, but fed slightly. Labium of mosquito bent up (probably owing to sugar solution sticking to it) and mosquito unable to straighten it. As a result of careful dipping in water the adherent sugar seemed to be washed away and the labium returned to its normal position. Now tried again repeatedly on Bull 2440; did not bite.

8-VII, 11-30 A.M. Tried for a long time on Bull 2442 in chupper 54; after considerable trouble succeeded in making it take a full feed.

11-VII, 9 A.M. Mosquito stuck up in sugar; brushed, washed and released it by means of a pin, but mosquito moribund.

12-VII, 7 A.M. Mosquito found dead with abdomen swollen.

Mosquito 6.

N.B. For early history, see under *Mosquito 5.*

31-V, 3 P.M. Tried on Control 2082; bit.

2-VI, 10 A.M. Tried on Bull 2222 in chupper 52; did not bite.

3-VI, 6 P.M. Fed on sugar solution.

4-VI, 10 A.M. Tried on Bull 2224 in chupper 53; bit.

6 P.M. Fed on sugar solution.

6-VI, 10-30 A.M. Tried on Bull 2223 in chupper 54; bit. Was not fed on sugar solution.

8-VI, 10-30 A.M. Tried on Bull 2245 in chupper 51; bit within a few minutes of application, although abdomen distended with sugar solution. Was not fed on sugar solution.

10-VI, 11 A.M. Tried on Bull 2241 in chupper 22; bit.

12-VI, noon. Tried on Bull 2243 in chupper 24; succeeded, after repeated attempts, in making it take a full feed.

14-VI, 11-30 A.M. Tried on Bull 2240 in chupper 26; bit.

16-VI, 10 A.M. Tried on Bull 2246 in chupper 29; bit.

18-VI, 11 A.M. Tried on Bull 2242 in chupper 30; bit.

20-VI, 11 A.M. Tried on Bull 2244 in chupper 32; bit very readily.

22-VI, noon. Tried on Bull 2348 in chupper 39; did not bite, although seemed to make efforts to puncture. Bull old.

24-VI. Not tried.

26-VI, 1-15 P.M Tried for a long time on Bull 2349 in chupper 42; did not bite.

28-VI, 12-30 P.M. Tried on Bull 2351 in chupper 43; did not bite, although it made efforts to puncture. Mosquito sluggish.

29-VI. Mosquito very sluggish.

30-VI. Mosquito somewhat crumpled up and wet with sticky sugar solution. Revived to a considerable extent after it was cleaned and dried.

12-30 P.M. Tried for a long time on Bull 2347 in chupper 45: did not bite. Mosquito very sluggish.

1-VII. Endeavoured to revive it, but mosquito moribund.

2-VII. Mosquito found dead.

Mosquito 8.

N.B. This was one of the mosquitos enclosed in bottle as No. 7 (see under *Mosquito 5*).

1-VI, noon. Tried No. 7 on Control 2079; did not bite.

3 P.M. Tried No. 7 again on Control 2079; did not bite. Fed on sugar solution.

2-VI, 10 A.M. Tried No. 7 on Control 2085; did not bite.
3 P.M. Tried No. 7 on Control 2085; one only bit and this was isolated and enclosed in tube as No. 8. One of the remaining two mosquitos escaped through netting and the other died.
4-VI, 10 A.M. Tried on Bull 2222 in chupper 52; did not bite.
6 P.M. Fed on sugar solution.
6-VI, 10 A.M. Tried repeatedly on Bull 2224 in chupper 53; did not bite.
8-VI, 9-30 A.M. Tried on Bull 2223 in chupper 54; did not bite. Mosquito sluggish.
6 P.M. Fed on sugar solution.
10-VI, 10-30 A.M. Tried on Bull 2245 in chupper 51; did not bite. Mosquito sluggish.
12-VI, 12-30 P.M. Tried on Bull 2241 in chupper 22; did not bite. Mosquito sluggish.
14-VI, 10-30 A.M. Tried on Bull 2243 in chupper 24; did not bite. Mosquito sluggish.
16-VI, 10-30 A.M. Tried on Bull 2240 in chupper 26; did not bite. Mosquito moribund.
18-VI, morning. Mosquito found almost dead.
Evening. Mosquito dead.

Mosquito 9.

2-VI, 10 A.M. Found emerged. Enclosed, with a large number of males, in bottle, with sugar solution.
3-VI, 10 A.M. Isolated with one male and enclosed in tube as No. 9. Tried on Control 2088; did not bite. Fed on sugar solution.
2 P.M. Tried on Control 2088; did not bite. Bull very hairy. Mosquito damaged and almost dead.

Mosquito 10.

3-VI, 3 P.M. Enclosed with one more female and 2 males in tube. Fed on sugar solution.
4-VI, noon. Tried on Control 2198; did not bite.
5-VI, 11 A.M. Tried on Control 2198; did not bite. Mosquito sluggish and slightly damaged.
Noon. Fed on sugar solution.
3-30 P.M. Tried on Control 2198; bit, but did not take a full feed.
7-VI, 10 A.M. Tried on Bull 2222 in chupper 53; did not bite. Mosquito moribund although abdomen distended with sugar solution.
10-VI, 5 P.M. Mosquito dead.

Mosquito 11.

4-VI, 4-30 P.M. 3 females and 1 male (emerged to-day) enclosed in bottle, with sugar solution.

5-VI, 11 A.M. Tried on Control 2198. One was fully gorged but escaped through netting; another also (unfed) escaped through netting; the third did not bite.
6-VI, 1 P.M. Tried the remaining female on Control 2198; did not bite.
4 P.M. Tried on Control 2198; bit.
7-VI. Enclosed the above gorged mosquito in tube as No. 11.
Noon. Fed on sugar solution.
8-VI, 10 A.M. Tried on Bull 2222 in chupper 52; did not bite.
10-VI, 10 A.M. Tried on Bull 2224 in chupper 53 did not bite.
12-VI, 11 A.M. Tried on Bull 2223 in chupper 54; bit.
14-VI, 10 A.M. Tried on Bull 2245 in chupper 51; did not bite.
16-VI, 12-30 P.M. Tried on Bull 2241 in chupper 22; did not bite
18-VI, 11-30 A.M. Tried on Bull 2243 in chupper 24; bit.
20-VI, 9-30 A.M. Tried on Bull 2240 in chupper 26; did not bite.
22-VI, 9-30 A.M. Tried on Bull 2246 in chupper 29; did not bite.
23-VI, 10 A.M. Mosquito moribund.

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Mosquito 12.

4-VI, 4-30 P.M. Found emerged. Enclosed in bottle with sugar solution. Mosquito probably virgin.
5-VI, 11 A.M. Tried on Control 2198; did not bite.
6-VI, 1 P.M. Tried on Control 2198; did not bite.
4 P.M. Tried again on Control 2198; bit.
7-VI, noon. Fed. on sugar solution.
8-VI, 10 A.M. Tried on Bull 2222 in chupper 52; did not bite.
10-VI, 10 A.M. Tried on Bull 2224 in chupper 53; did not bite.
12-VI, 11 A.M. Tried on Bull 2223 in chupper 54; bit.
14-VI, 10 A.M. Tried on Bull 2245 in chupper 51; did not bite.
16-VI, 12-30 P.M. Tried on Bull 2241 in chupper 24; did not bite.
18-VI, 11-30 A.M. Tried on Bull 2243 in chupper 24; did not bite.
20-VI, 9-30 A.M. Tried on Bull 2240 in chupper 26; did not bite. Mosquito slightly damaged.
22-VI, 9-30 A.M. Tried on Bull 2246 in chupper 29; did not bite.
23-VI, 10 A.M. Mosquito found dead.

No. 13. (Two mosquitos.)

6-VI, 3-30 P.M. Found emerged. Enclosed with another female and 4 males, in bottle, with sugar solution.
8-VI, noon. Tried on Control 2229; two fed. These two enclosed in tube as No 13.
10-VI, 10 A.M. Tried on Bull 2222 in chupper 52; both bit.
12-VI, 10-30 A.M. Tried on Bull 2224 in chupper 53; one bit.

14-VI, 9-30 A.M. One dead. Tried the other on Bull 2223 in chupper 53; did not bite.
16-VI, 11-30 A.M. Tried on Bull 2245 in chupper 51; bit.
18-VI, 11-30 A.M. Tried on Bull 2241 in chupper 22; did not bite.
20-VI, 10 A.M. Tried on Bull 2243 in chupper 24; bit.
22-VI, 10 A.M. Tried on Bull 2240 in chupper 26; did not bite. Mosquito not quite happy.
24-VI. Not tried.
26-VI, 11-30 A.M. Tried on Bull 2242 in chupper 30; bit.
28-VI, 11-30 A.M. Tried on Bull 2244 in chupper 32; did not bite.
29-VI. Mosquito stuck up in sugar solution and moribund.

Mosquito 14.

7-VI, 3 P.M. Found emerged. Enclosed with two more females and 4 males, in bottle, with sugar solution.
9-VI, 11-30 A.M. Tried on Control 2118; none bit.
3-30 P.M. Tried on Control 2118; one bit. Enclosed this in tube as No. 14.
11-VI, 9-30 A.M. Tried on Bull 2222 in chupper 52; did not bite.
13-VI, 10 A.M. Tried on Bull 2224 in chupper 53; bit.
15-VI, 9-45 A.M. Tried on Bull 2223 in chupper 54; did not bite.
17-VI, 11 A.M. Tried on Bull 2245 in chupper 51; bit within a few minutes of application and had a very full feed.
19-VI, 11 A.M. Tried on Bull 2241 in chupper 22; did not bite.
21-VI, 10 A.M. Tried on Bull 2243 in chupper 24; bit.
23-VI, 10 A.M. Mosquito moribund.

No. 14(a). (Five Mosquitos.) [Kept in bottle, with sugar solution in lid.]

This batch of mosquitos was composed as follows:—

(1) 5-VI. 1 newly-emerged male, 3 males (emerged on 1. VI) and 2 newly-emerged females, enclosed in bottle, with sugar solution.
6-VI, 3-30 P.M. Sugar solution substituted by plain water.
8-VI, noon. Tried on Control 2229; none bit.
8-VI. The females mentioned above, along with 3 more females (age not noted), enclosed in bottle, with sugar solution.
8-VI, 4 P.M. Tried on Control 2229; none bit.
9-VI, 11 A.M. 1 female dead.
11-30 A.M. Tried on Control 2118; none bit.
3-40 P.M. Tried again on Control 2118; none bit.
10-VI (hour not noted). Tried on Control 2107; none bit.
(2) 8-VI, 4-15 P.M. Enclosed 6 newly-emerged females with sugar solution, in bottle.
9-VI. Not tried.

10-VI, 3 P.M. Tried on Control 2107; 4 bit. One of the remaining two mosquitos killed as a result of being pressed by netting on rim of bottle.

The five engorged mosquitos now kept together in bottle with sugar solution in cavity of lid and labelled as No. 14 (*a*).

12-VI, 10 A.M. Tried on Bull 2222 in chupper 52; none bit.

13-VI, evening. 1 found dead in sugar solution.

14-VI, morning. Another found dead and a third escaped, so that only 2 now left. 9-15 A.M. Tried on Bull 2224 in chupper 53; did not bite. Mosquitos difficult to control.

16-VI, 11-15 A.M. Tried on Bull 2223 in chupper 54; 1 bit.

18-VI, noon. Tried on Bull 2245 in chupper 51; 1 bit, although its abdomen distended with sugar solution; the other, although its abdomen thin, did not bite.

20-VI, 10 A.M. Tried on Bull 2241 in chupper 22; bit, although its abdomen distended with sugar solution; the other, although very thin, did not bite.

22-VI. Not tried.

24-VI. Not tried.

26-VI, 11 A.M. Tried on Bull 2246 chupper 29; did not bite.

28-VI, 1 P.M. Enclosed the two mosquitos separately in tubes. Tried on Bull 2242 in chupper 30; did not bite.

30-VI, 11 A.M. Tried on Bull 2244 in chupper 32; both bit.

2-VII, 11-45 A.M. Tried on Bull 2348 in chupper 39; both bit. Bull old and its skin very thick.

4-VII, 2 P.M. Tried on Bull 2346 in chupper 41; 1 bit, the other did not bite (it looked gravid and was very sluggish, almost moribund).

6-VII, 1 P.M. Tried on Bull 2349 in chupper 42; did not bite. 1 mosquito only now alive.

8-VII, noon. Tried on Bull 2462(?) in chupper 43 for a long time; took a full feed.

10-VII, 11-30 A.M. Tried for a long time on Bull 2347 in chupper 45; bit, but did not take a full feed. Mosquito sluggish and seems gravid.

14-VII, 10-50 A.M. Tried on Bull 2440 in chupper 52; bit, although mosquito much mutilated and incapable of locomotion, two of its legs being torn off and wings stuck together with sugar solution.

17-VII, 6 P.M. Mosquito moribund.

18-VII, 10 A.M. Mosquito found dead.

Mosquito 15. (*Mosquito not well-developed.*)

[Continued from (1) of the preceding experiment.]

11-VI, 11-30 A.M. Tried the remaining 3 mosquitos on Control 2126; did not bite.
3 P.M. Tried again on Control 2126; 1 bit. This now enclosed in tube as No. 15.

13-VI, 9-30 A.M. Tried on Bull 2222 in chupper 52; did not bite. Mosquito sluggish.

15-VI, 9-30 A.M. Tried on Bull 2224 in chupper 53; did not bite.

17-VI, 10-30 A.M. Tried on Bull 2223 in chupper 54; did not bite.

19-VI, 10 A.M. Tried on Bull 2245 in chupper 51; did not bite.

21-VI, 9-30 A.M. Tried on Bull 2241 in chupper 22; did not bite.

23-VI, 9 A.M. Tried on Bull 2243 in chupper 24; did not bite. Mosquito moribund.

11 A.M. Mosquito found dead.

No. 15 (a) (Ten mosquitos.)

9-VI, 3-30 P.M. Enclosed a large number of newly-emerged males and females in bottle, with sugar solution.

10-VI, noon. Enclosed a large number of females and only 1 male, in bottle with sugar solution.

12-VI, 3 P.M. All the above mosquitos enclosed together in a bottle. The mosquitos appeared to be somewhat unusually well-developed. Tried on Control 2126; 10 bit. The engorged females enclosed together in bottle as No. 15 (*a*).

14-VI, Not tried.

16-VI, 11 A.M. Tried on Bull 2224 in chupper 53; none bit.

17-VI, 5-30 P.M. A batch of eggs found laid on sugar solution.

18-VI, 12-30 P.M. Tried on Bull 2223 in chupper 54; none bit. A few more eggs found laid on sugar solution.

20-VI, 11-7 A.M. Tried on Bull 2245 in chupper 51; none bit. Extremely difficult to control the mosquitos.

22-VI, 10-15 A.M. Tried on Bull 2241 in chupper 22; none bit. 1 mosquito dead.

24-VI, Not Tried.

26-VI, 11-45 A.M. Tried on Bull 2240 in chupper 26; none bit. Only 5 mosquitos survive.

28-VI, 1-10 P.M. Tried on Bull 2246 in chupper 29; none bit. Only 2 mosquitos left and these kept separately in tubes.

30-VI, noon. Tried on Bull 2242 in chupper 30; did not bite. Only 1 mosquito left.

2-VII, 10 A.M. The surviving mosquito found dead.

Mosquito 16.

16-VI, 4-45 P.M. Found emerged. Fed on sugar solution and enclosed in tube.

17-VI, Not tried.

18-VI, 3-15 P.M. Tried on Control 2117; bit.

20-VI, 11-30 A.M. Tried on Bull 2222 in chupper 52; did not bite.

22 VI, 11 A.M. Tried on Bull 2224 in chupper 53; bit.

24-VI. Not tried.
26-VI, noon. Tried on Bull 2245 in chupper 51 ; bit.
28-VI 10-30 A.M. Tried on Bull 2241 in chupper 22 ; did not bite.
30-VI 11-30 A.M. Tried for a long time on Bull 2243 in chupper 24 ; did not bit
2-VII, 12-30 P.M. Tried on Bull 2240 in chupper 26 ; bite.
4-VII, 1 P.M. Tried on Bull 2246 in chupper 29 ; did not bite.
6-VII, 10-30 A.M. Tried for a long time on Bull 2242 in chupper 30 ; (?) slightly fed. Mosquito not happy and looks gravid.
8-VII, 11 A.M. Tried for a long time on Bull 2244 in chupper 32 ; showed no inclination to bite, rather repelled.
10-VII, noon. Tried on Bull 2348 in chupper 39 for a long time ; did not bite Mosquito mutilated and incapable of locomotion ; probably moribund
11-VII. Mosquito found dead.

No. 17. (Two mosquitos.)

15-VI, 3 P.M. Enclosed 2 newly-emerged mosquitos in tube. Fed on sugar solution.
16-VI, 3 P.M. Tried on Control 2086 ; none bit. Fed on sugar solution.
17-VI, Not tried. Fed on sugar solution.
18-VI, 3 P.M. Tried on Control 2117 ; 1 bit ; the other refused to bite, but as it made attempts to puncture when tried on my own arm about ten minutes later, it was again tried on Control 2117, when it bit readily.
20-VI, 11-30 A.M. Tried on Bull 2222 in chupper 52 ; none bit.
22-VI, 11 A.M. Tried on Bull 2224 in chupper 53 ; 1 bit.
24-VI, Not tried.
26-VI, noon. One dead. Tried the remaining one on Bull 2245 in chupper 51 ; bit.
28-VI, 10-30 A.M. Tried on Bull 2241 in chupper 22 ; did not bite.
30-VI 11-30 A.M. Tried on Bull 2243 in chupper 24 ; bit.
2-VII, 12-30 P.M. Tried for a long time on Bull 2240 in chupper 26 ; did not bite.
4-VII, 1 P.M. Tried on Bull 2246 in chupper 29 ; did not bite. Mosquito suddenly collapsed, when seemed about to bite. Applied moisture but it did not revive.

Mosquito 18.

14-VI. 3 newly-emerged females and 1 newly-emerged male of *A.(S.) thomsoni* and 1 newly-emerged female of *A.(S.) albopicta* fed on sugar solution and enclosed in tube.
15-VI, morning and afternoon. Tried on Control 2086 ; none bit. Transferred mosquitos to bottle.
16-VI, 3-30 P.M. Tried on Control 2086 ; none bit. Fed on sugar solution.
17-VI, noon. Tried on Control 2086 ; none bit. Fed on sugar solution.
18-VI, 3-30 P.M. Tried on Control 2117 ; only *albopicta* bit. Enclosed this in tube as No. 18.
20-VI, 11-30 A.M. Tried on Bull 2222 in chupper 52 ; did not bite.

22-VI, 11 A.M. Tried on Bull 2224 in chupper 53; did not bite.
24-VI, Not tried.
26-VI, noon. Tried on Bull 2245 in chupper 51; bit.
28-VI, 10-30 A.M. Mosquito found dead.

Mosquito 19.

20-VI, 1 P.M. 3 newly-emerged females and 1 male fed on sugar solution and enclosed in tube.
Tried on Control 2130; did not feed, although made attempts to puncture.
3-30 P.M. Tried again on Control 2130; none bit.
21-VI, 11-45 A.M. Tried on Control 2078; 1 bit. Enclosed this separately in tube as No. 19.
23-VI, 9-30 A.M. Tried on Bull 2222 in chupper 52; bit.
25-VI. Not tried.
27-VI, 10-15 A.M. Tried on Bull 2223 in chupper 54; bit.
29-VI, 10-15 A.M. Tried on Bull 2245 in chupper 51; did not bite. Mosquito not quite happy.
1-VII, noon. Mosquito found dead.

Mosquito 20.

21-VI, 4 P.M. The two remaining mosquitos, which could not be made to bite Control at 11-45 A.M. (*vide* last experiment), were tried again on Control 2078; none bit. Fed on sugar solution.
22-VI, 3 P.M. Tried on Control 2078; none bit.
23-VI, 11 A.M. Tried on Control 2119; none bit.
26-VI, 4 P.M. Tried on Control 2066; 1 bit. Enclosed this separately in tube as No. 20.
28-VI, 11-45 A.M. Tried on Bull 2222 in chupper 52; did not bite. Mosquito not happy.
30-VI. Mosquito found dead.

Mosquitos 21, 22, 23, 25 and 26.

20-VI, 1 P.M. Enclosed a large number of females (emerged yesterday and to-day) in bottle, with sugar solution.
22-VI, 11 A.M. Tried on Control 2119; none bit. Offered fresh sugar solution.
26-VI, 4 P.M. Tried on Control 2066; none bit.
27-VI, noon. One of the females enclosed, together with a male, in a tube; the rest enclosed singly in tubes.
3 P.M. Tried on Control 2119; 3 bit, including the one that had been enclosed with a male, but this fed only slightly. The three fed mosquitos enclosed singly in tubes as Nos. 21, 22 and 23.
28-VI, 4 P.M Tried the remaining on Control 2312, 3 bit. 2 enclosed together in one tube as No. 25; the other enclosed singly in tube as No. 26.

Mosquito 21.

N.B. For early history see above.

27-VI, 3 P.M. Fed on Control 2119.
29-VI, 11 A.M. Tried on Bull 2222 in chupper 52 ; bit.
1-VII, 10-30 A.M. Tried on Bull 2224 in chupper 53 ; bit.
3-VII, 11 A.M. Tried on Bull 2223 in chupper 51 (removed from chupper 54) ; bit.
5-VII, 10-30 A.M. Tried on Bull 2245 in chupper 51 ; bit.
7-VII, 11 A.M. Tried on Bull 2241 in chupper 24 (removed from chupper 22) ; bit.
9-VII, 10-30 A.M. Tried for a long time on Bull 2243 in chupper 24 ; bit.
11-VII, 11 A.M. Tried for a long time on Bull 2240 in chupper 26 ; did not bite. 4 P.M. Tried again on Bull 2240 in chupper 26 ; did not bite.
13-VII, 11 A.M. Tried on Bull 2246 in chupper 29 ; did not bite.
15-VII. Mosquito found dead.

Mosquito 22.

N.B. For previous history see above.

27-VI, 4 P.M. Fed on Control 2119.
29-VI, 11 A.M. Tried on Bull 2222 in chupper 52 ; bit.
1-VII, 10-30 A.M. Tried on Bull 2224 in chupper 53 ; bit.
3-VII, 11 A.M. Tried on Bull 2223 in chupper 51 (removed from chupper 54) ; bit.
5-VII, 10-30 A.M. Tried for a long time on Bull 2245 in chupper 51 ; bit.
7-VII, 11 A.M. Tried for a long time on Bull 2241 in chupper 24 (removed from chupper 22) ; did not bite.
9-VII, 10-30 A.M. Tried on Bull 2243 in chupper 24 ; bit very readily
11-VII, 9 A.M. mosquito almost dead after ovipositing on muslin cover or tube. Tried to revive it but failed.

Mosquito 23.

N.B. For previous history see above.

27-VI, 4 P.M. Fed on Control 2119.
29-VI, 11 A.M. Tried on Bull 2222 in chupper 52 ; bit.
1-VII, 10-30 A.M. Tried on Bull 2224 in chupper 53 ; bit.
3-VII, 11 A.M. Tried on Bull 2223 in chupper 51 (removed from chupper 54) ; at first it went on moving about on muslin making occasional attempts at puncturing, but after a while it settled down all on a sudden and took a full feed.
5-VII. Mosquito found dead and distended.

Mosquito 24.

28-VI, 4 P.M. Fed slightly on Control 2312.

30-VI, 10-30 A.M. Tried on Bull 2222 in chupper 52 ; did not bite.

2-VII, 11 A.M. Tried on Bull 2224 in chupper 53 ; bit.

4-VII, noon. Tried on Bull 2223 in chupper 51 (removed from chupper 54) ; bit.

6-VII, noon. Tried for a fairly long time on Bull 2245 in chupper 51 ; bit.

8-VII, 10 A.M. Tried on Bull 2241 in chupper 24 (removed from chupper 22) ; did not bite. Mosquito sluggish.

10-VII, 10-30 A.M. Tried on Bull 2243 in chupper 24 ; bit, but not readily.

12-VII, 10-30 A.M. Tried on Bull 2240 in chupper 26 ; succeeded, with the greatest difficulty in making it bite. Mosquito somewhat sticky with sugar and very sluggish.

14-VII, 11-30 A.M. Tried on Bull 2246 in chupper 29 ; did not bite. Mosquito moribund, but appeared to revive a little when moisture was applied.

15-VII. Mosquito found dead.

No. 25. (Two mosquitos.)

N.B. For previous history see above.

28-VI, 4 P.M. Fed on Control 2312.

30-VI, 10-30 A.M. Tried on Bull 2222 in chupper 52 ; did not bite.

2-VII, 11 A.M. Tried on Bull 2224 in chupper 53 ; bit.

4-VII, noon. Tried on Bull 2223 in chupper 51 (removed from chupper 54) ; both bit.

6-VII. Both mosquitos found dead.

Mosquito 26.

N.B. For previous history see above.

28-VI, 4 P.M. Fed on Control 2312.

30-VI. Not tried.

2-VII, 11 A.M. Found dead.

Mosquito 27.

10-VII. Found emerged. Fed on sugar solution.

11-VII (hour not noted). Tried on Control 2323 ; did not bite.

12-VII, noon. Tried on Control 2340 ; bit.

14-VII, 10-30 A.M. Tried on Bull 2222 in chupper 52 ; bit.

16-VII, 11-30 A.M. Tried thrice at short intervals on Bull 2224 in chupper 53 ; it appeared unable to puncture the skin, although it seemed anxious to bite, but it bit when muslin cover of tube was pressed hard on ear to effect contact of mosquito with skin.

18-VII, 12-30 P.M.—2 P.M. Tried for about 1½ hours on Bull 2223 in chupper 51 ; did not bite although arduous efforts were made to make it do so.

20-VII, morning. Mosquito found dead.

Mosquito 28.

11-VII. Found emerged. Fed on sugar solution.

12-VII, 1 P.M. Tried on Control 2340 ; bit.

14-VII, 10-30 A.M. Tried on Bull 2222 in chupper 52 ; bit.

16-VII, 11-30 A.M. Abdomen of mosquito distended with a whitish mess. Tried repeatedly on Bull 2224 in chupper 53 ; did not feed although it appeared to puncture, but bit when muslin was stretched.

18-VII, 12-30 P.M. Tried repeatedly on Bull 2223 in chupper 51 ; bit. It fed in two instalments. The excrement voided immediately after the first feed appeared to consist of blood, whilst that passed after the second feed was, as is usual, *liquor sanguinis.*

20-VII, noon. Mosquito quite happy and active. Tried repeatedly and at intervals on Bull 2245 in chupper 51 ; bit.

22-VII, noon. Tried on Bull 2241 in chupper 24 ; bit fairly readily.

24-VII, 7-30 A.M. Mosquito found dead and distended.

Mosquito 29.

11-VII. Found emerged.

3 P.M. Fed on sugar solution.

12-VII, noon. Tried on Control 2340 ; did not bite.

4-30 P.M. Tried on Control 2340 ; did not bite.

13-VII, noon. Tried on Control 2340 ; bit.

15-VII, 10-30 A.M. Tried on Bull 2222 in chupper 53 (removed from chupper 52 ; bit.

17-VII, 11 A.M. Mosquito found dead.

Mosquito 30.

12-VII. Found emerged.

3-30 P.M. Fed on sugar solution.

13-VII, noon. Tried on Control 2340 ; bit.

15-VII, 10-30 A.M. Tried on Bull 2222 in chupper 53 (transferred from chupper 52) ; bit readily.

17-VII, 10-30 A.M. Tried on Bull 2224 in chupper 53 ; bit read ly.

19-VII, 11-20 A.M. Tried repeatedly on Bull 2223 in chupper 51 ; bit. Noticed that muslin must be kept sufficiently stretched in order to secure a successful feed ; in the present case muslin had tc be removed and retied.

21-VII, noon. Tried on Bull 2245 in chupper 51 ; bit readily.

23-VII, 10-30 A.M. Mosquito found dead.

Mosquito 31.

12-VII, 3-30 P.M. Found emerged. Fed on sugar solution.
13-VII, noon. Tried on Control 2340; bit.
15-VII, 10-30 A.M. Tried on Bull 2222 in chupper 53 (transferred from chupper 52); bit readily.
17-VII, 10-30 A.M. Tried on Bull 2224 in chupper 53; bit readily.
19-VII, 11-30 A.M. Tried repeatedly and for a long time on Bull 2223 in chupper 51; bit. Noticed that muslin must be kept stretched to effect a good feed.
21-VII, noon. Mosquito found dead, although abdomen still distended with blood.

Mosquito 32.

12-VII. Found emerged.
3-30 P.M. Fed on sugar solution.
13-VII, noon. Tried on Control 2340; bit.
15-VII, 10-30 A.M. Tried on Bull 2222 in chupper 53, bit readily.
17-VII, 10-30 A.M. Tried on Bull 2224 in chupper 53; bit readily.
19-VII, noon. Mosquito sluggish. Tried repeatedly on Bull 2223 in chupper 51; did not bite.
5 P.M. Tried repeatedly on Bull 2223 in chupper 51; did not bite. Mosquito damaged as a result of continuous handling.
20-VII, 10 A.M. Mosquito found dead.

Mosquito 33.

12-VII. Found emerged.
3-30 P.M. Fed on sugar solution.
13-VII, 12-30 P.M. Tried on Control 2340; did not bite.
14-VII, 11 A.M.—2 P.M. Tried on Control 2475 (young bull); bit.
16-VII, 1 P.M. Tried for about 2 hours on Bull 2222 in chupper 53; did not bite. Proboscis bent upwards and mosquito never attempted to puncture.
18-VII, 10-30 A.M. Tried repeatedly on Bull 2224 in chupper 53; bit.
20-VII, 10-30 A.M. Mosquito found dead.

Mosquito 34.

12-VII, 3-30 P.M. Found emerged. Fed on sugar solution.
13-VII, noon. Tried on Control 2340; did not bite.
14-VII, 11 A.M.—2 P.M. Tried on Control 2475; bit.
16-VII, 11 A.M.—1 P.M. Tried repeatedly and at intervals on Bull 2222 in chupper 53; bit. Bull difficult to immobilize.
18-VII, 10-30 A.M.—12-30 P.M. Tried at intervals on Bull 2224 in chupper 53; bit, but was not fully gorged.

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20-VII, 11-30 A.M. Tried at intervals and for a long time on Bull 2223 in chupper 53 ; bit, but was not fully gorged. Mosquito very sluggish.
21-VII, 8 A.M. Mosquito found dead.

Mosquito 35.

13-VII, noon. Found emerged.
4 P.M. Fed on sugar solution.
14-VII, 11 A.M.—1 P.M. Tried on Control 2475 ; bit.
16-VII, 11 A.M.—1 P.M. Tried on Bull 2222 in chupper 53 ; bit very readily. Bull extremely difficult to immobilize.
18-VII, 10-30 A.M. Tried at intervals for about 1½ hours on Bull 2224 in chupper 53 ; bit. Abdomen of mosquito distended with a white mass.
20-VII, 11 A.M. Tried on Bull 2223 in chupper 51 ; bit readily.
22-VII, 11-30 A.M. Tried on Bull 2245 in chupper 51 ; bit fairly readily.
24-VII, 10-40 A.M. Tried repeatedly on Bull 2241 in chupper 24 ; bit. Abdomen of mosquito distended with a white mass.
26-VII, 11 A.M. Tried repeatedly on Bull 2243 in chupper 24 ; did not bite.
28-VII, 10-45 A.M. Tried on Bull 2240 in chupper 26 ; did not bite.
30-VII, 3-25 P.M. Tried on Bull 2246 in chupper 29 ; bit fairly readily.
1-VIII, 11-30 A.M. Tried on Bull 2242 in chupper 30 ; bit fairly readily. Abdomen distended with a white mass.
3-VIII, 11-30 A.M. Tried on Bull 2224 in chupper 26 (transferred from chupper 32) ; did not bite. Mosquito sluggish.
5-VIII, 11-30 A.M. Tried on Bull 2348 in chupper 39 ; did not bite.
7-VIII, 11-30 A.M. Tried on Bull 2626 in chupper 41 ; bit.
9-VIII, 11 A.M. Tried on Bull 2599 in chupper 42 ; did not bite. Except for the anterior end, which was bordered with a black material, the whole abdomen was distended with a white mass.
11-VIII, 11 A.M. Tried on Bull 2462(?) in chupper 43 ; did not bite, although it made attempts to puncture. Tried on inner sides of ear of the animal, but with no better success. Bull old, its skin thick and hairy.
13-VIII, 5-45 P.M. Mosquito crushed and inoculated into Bull 2723 (*vide* Inoculation experiments.)

Mosquito 36.

11-VII, Found emerged.
3 P.M. Fed on sugar solution.
12-VII, noon. Tried on Control 2340 ; did not bite. Bull old.
4 P.M. Tried on Control 2340 ; did not bite.
13-VII, noon. Tried on Control 2340 ; did not bite.
14-VII, 11 A.M.—1 P.M. Tried on Control 2475 (young bull) ; did not bite.
15-VII, 12-30 P.M. Tried on Control 2472 ; bit.

17-VII, 11-30 A.M. Tried on Bull 2222 in chupper 53 ; bit readily.

19-VII, 12-30 P.M. Tried repeatedly on Bull 2224 in chupper 53 ; fed in two instalments. Bit only when muslin was properly stretched.

21-VII, 10-30 A.M. Tried repeatedly on Bull 2223 in chupper 51 ; bit.

23-VII, 12-30 P.M. Tried repeatedly and at intervals on Bull 2245 in chupper 51 ; did not bite.

25-VII, 11 A.M. Tried at intervals on Bull 2241 in chupper 24 ; did not bite.

27-VII. Mosquito found dead.

Mosquito 37.

13-VII, noon. Found emerged.

4 P.M. Fed on sugar solution.

14-VII, 11 A.M.—1 P.M. Tried on Control 2475 (young bull) ; did not bite.

15-VII, 12-30 P.M. Tried on Control 2472 ; bit.

17-VII, 11-30 A.M. Tried on Bull 2222 in chupper 53 ; bit fairly readily.

19-VII, 12-45 P.M. Tried repeatedly on Bull 2224 in chupper 53 ; fed in two instalments. Bit at the last moment, when it was going to be given up as hopeless.

21-VII, 10-30 A.M.—12 noon. Tried repeatedly on Bull 2223 in chupper 51 ; bit when it was going to be given up as hopeless.

23-VII, 12-30 P.M. Tried repeatedly and at intervals on Bull 2245 in chupper 51 ; did not bite.

25-VII, 11 A.M. Tried at intervals on Bull 2241 in chupper 24 ; did not bite.

27-VII, 10-30 A.M. Tried on Bull 2243 in chupper 24 ; did not bite.

29-VII, 10-30 A.M. Tried for about $1\frac{1}{2}$ hours on Bull 2240 in chupper 26 ; did not bite.

31-VII, 10-30 A.M. Tried repeatedly on Bull 2246 in chupper 29 ; did not bite. Mosquito not fed on raisins or sugar since evening of 28-VII. Mosquito without one leg and appears somewhat frantic, although fairly active.

2-VIII, 10-30 A.M. Tried repeatedly on Bull 2242 in chupper 30 ; did not bite. Condition of mosquito same as on 31-VII.

noon. Put in raisins.

4-VIII, 10 A.M. Tried on Bull 2244 in chupper 26 ; did not bite.

6-VIII, 10-30 A.M. Tried on Bull 2627 (young bull) in chupper 39 ; did not bite.

8-VIII, 11 A.M. Tried for a long time on Bull 2626 in chupper 41 ; did not bite. Mosquito thin but fairly active.

10-VIII, morning. Mosquito moribund.

1 P.M. Tried on Bull 2599 in chupper 42 ; did not bite. Mosquito almost dead.

Mosquito 38.

13-VII. Found emerged. Tried on Control 2472 ; did not bite, although when placed on my arm it made efforts to puncture the skin.

3 P.M. Fed on sugar solution.

14-VII, 11 A.M.—1 P.M. Tried on Control 2475 (young bull); did not bite.
15-VII, 12-30 P.M. Tried on Control 2472; bit.
17-VII, 11-30 A.M. Tried on Bull 2222 in chupper 53; did not feed readily and fed only slightly. While refixing loose muslin, mosquito lost two legs and was, in other ways, much mutilated as it made frantic efforts to escape.

Mosquito 39.

14-VII, 11 A.M. Found emerged.
3 P.M. Fed on sugar solution.
15-VII, 12-30 P.M. Tried on Control 2472; did not bite.
Fed on sugar solution.
16-VII, 2-30 P.M. Tried on Control 2472; did not bite.
3-30 P.M. Fed on sugar solution.
17-VII, 1 P.M. Tried on Control 2404; bit.
19-VII, 1-20 P.M. Tried repeatedly on Bull 2222 in chupper 53; bit, but was not fully gorged.
21-VII, 12-45 P.M. Tried on Bull 2224 in chupper 53; bit fairly readily.
23-VII, 11 A.M. Tried repeatedly on Bull 2223 in chupper 51; bit.
24-VII, 6 P.M. Tied up raisin on muslin of tube.
25-VII, 7-30 A.M. Abdomen of mosquito full of juice of raisin.
Noon. Tried repeatedly and at intervals on Bull 2245 in chupper 51; did not bite.
27-VII, 1 P.M. Tried repeatedly and at intervals on Bull 2241 in chupper 24; did not bite.
29-VII, 12-30 P.M. Tried repeatedly and at intervals on Bull 2243 in chupper 24; did not bite.
31-VII, 11 A.M. Tried repeatedly and at intervals on Bull 2240 in chupper 26; did not bite. Mosquito all on a sudden collapsed while being tried (somewhat violently) on this bull. Bull difficult to immobilize. Mosquito had no raisin or sugar solution since evening of 28-VII.

Mosquito 40.

15-VII, noon. Found emerged.
1 P.M. Fed on sugar solution.
16-VII, 2-30 P.M. Tried on Control 2472; did not bite
3-30 P.M. Fed on sugar solution.
17-VII, 1 P.M. Tried on Control 2404; did not bite.
3 P.M. Tried repeatedly on Control 2404; bit.
19-VII, 1-30 P.M. Tried repeatedly on Bull 2222 in chupper 53; bit.
21-VII, 1 P.M. Tried at intervals on Bull 2224 in chupper 53; bit. Bull difficult to immobilize.

23-VII, 11-15 A.M. Tried repeatedly on Bull 2223 in chupper 51 ; bit.
24-VII, 6-P.M. Changed muslin and tied up fresh raisin.
25-VII, 7-30 A.M. Abdomen of mosquito distended with juice of raisin.
Noon. Tried repeatedly and at intervals on Bull 2245 in chupper 51 ; did not bite.
27-VII, noon. Tried repeatedly and at intervals on Bull 2241 in chupper 24 ; bit. Noticed that when there was an excess of moisture in the muslin, the mosquito refused to bite, and it bit when the moisture had been allowed to evaporate.
29-VII, 12-30 P.M. Tried repeatedly and at intervals on Bull 2243 in chupper 24 ; did not bite.
31-VII, 11 A.M. Tried repeatedly and at intervals on Bull 2240 in chupper 26 ; did not bite. No raisin given since evening of 28-VII.
2-VIII, 11-10 A.M. Tried repeatedly on Bull 2246 in chupper 29 ; bit.
4-VIII, 12-45 P.M. Tried on Bull 2242 in chupper 30 ; bit fairly readily.
6-VIII, 11-30 A.M. Tried on Bull 2244 in chupper 26 ; did not bite.
8-VIII, 11-45 A.M. Tried on Bull 2627 in chupper 39 ; did not bite.
10-VIII, 11-30 A.M. Mosquito found dead.

Mosquito 41.

15-VII, noon. Found emerged.
1 P.M. Fed on sugar solution.
16-VII, 2-30 P.M. Tried on Control 2472 ; did not bite.
3-30 P.M. Fed on sugar solution.
17-VII, 1 P.M. Tried on Control 2404 ; did dot bite.
1-10 P.M. Tried on my arm and it showed readiness to bite.
3 P.M. Tried again on Control 2404 ; bit.
19-VII, 1-45 P.M. Tried on Bull 2222 in chupper 53 ; bit readily and became fully gorged very quickly.
21-VII, 1-10 P.M. Tried at intervals on Bull 2224 in chupper 53 ; bit.
23-VII, 11-50 A.M. Tried repeatedly on Bull 2223 in chupper 51 ; did not bite.
Applied moisture on skin of animal to see if that would induce mosquito to bite, but result was negative.
24-VII, 6 P.M. Changed muslin and tied up fresh raisin.
25-VII, 7-30 P.M. Abdomen of mosquito full of juice of raisin.
noon. Tried repeatedly and at intervals on Bull 2245 in chupper 51 ; did not bite.
27-VII, 1 P.M. Tried repeatedly and at intervals on Bull 2241 in chupper 24 ; did not bite.
29-VII, 12-30 P.M. Tried repeatedly and at intervals on Bull 2243 in chupper 24 ; did not bite.

31-VII, 11 A.M. Tried repeatedly and at intervals on Bull 2240 in chupper 26; did not bite. No raisin given since evening of 28-VII.
2-VIII, 11-10 A.M. Mosquito found dead.

Mosquito 42.

20-VII, 4 P.M. Found emerged. Was not fed on sugar solution or raisin.
21-VII. No Control available to-day.
3-40 P.M. Fed on sugar solution.
22-VII, 2 P.M. Fed on sugar solution.
No Control available to-day.
23-VII, 3 P.M. Tried on Control 2436; bit.
24-VII, 6 P.M. Tied up raisin on muslin.
25-VII, 7-30 A.M. Abdomen of mosquito full of juice of raisin.
12-45 P.M. Tried repeatedly on Bull 2222 in chupper 53; did not bite. Abdomen of mosquito still full of raisin juice.
27-VII, 1-15 P.M. Tried on Bull 2224 in chupper 53; did not bite.
Skin of animal wet, having been washed with water to remove adherent dung.
29-VII, 1 P.M. Tried repeatedly on Bull 2223 in chupper 51; did not bite.
31-VII, noon. Tried repeatedly on Bull 2245 in chupper 51; did not bite, although mosquito made attempts to puncture.
2-VIII, 1-45 P.M. Tried repeatedly on Bull 2241 in chupper 24; bit.
4-VIII, 11 A.M. Tried on Bull 2243 in chupper 24; did not bite.
6-VIII, 11-30 A.M. Tried on Bull 2240 in chupper 26; did not bite.
8-VIII, noon. Tried on Bull 2246 in chupper 29; fed slowly and was not fully gorged.
10-VIII, 11-30 A.M. Tried on Bull 2242 in chupper 30; bit.
12-VIII, 11 A.M. Tried on Bull 2244 in chupper 26; bit.
13-VIII, 5-45 P.M. Crushed and inoculated into Bull 2723. (*Vide* Inoculation experiments.)

Mosquito 43.

24-VII. Found emerged.
3-30 P.M. Enclosed in tube with raisin.
25-VII, 2-30 P.M.—4-30 P.M. Tried repeatedly on Control 2354 (young bull); did not bite.
26-VII, noon and 3 P.M. Tried repeatedly on Control 2436; did not bite.
4 P.M. Removed raisin.
27-VII, 3-30 P.M. Tried on Control 2350; bit.
29-VII, 1-27 P.M. Tried repeatedly and at intervals on Bull 2222 in chupper 53; mosquito succeeded in biting after some attempts. Mosquito has had no raisin since infective feed.

31-VII, 12-30 P.M. Tried repeatedly on Bull 2224 in chupper 53; mosquito succeeded in biting after some attempts.
2-VIII, 12-20 P.M. Tried repeatedly and at intervals on Bull 2223 in chupper 51; bit.
4-VIII, 11-30 A.M. Tried on Bull 2245 in chupper 51; did not bite.
6-VIII, noon. Tried on Bull 2241 in chupper 24; bit.
8-VIII, 11 A.M. Mosquito found dead.

Mosquito 44.

24-VII, Found emerged.
3-30 P.M. Enclosed in tube with raisin.
25-VII, 2-30—4-30 P.M. Tried repeatedly on Control 2354 (young bull); did not bite.
26-VII, noon and 3 P.M. Tried on Control 2436; did not bite.
4 P.M. Removed raisin.
27-VII, 3-30 P.M. Tried on Control 2350; bit.
29-VII, 1-15 P.M. Tried on Bull 2222 in chupper 53; bit. Mosquito kept without raisin since infective feed.
31-VII, 12-30 P.M. Tried on Bull 2224 in chupper 53; bit.
2-VIII, 12-30 P.M. Tried on Bull 2223 in chupper 51; bit readily.
4-VIII, 11-30 A.M. Tried on Bull 2245 in chupper 51; bit.
6-VIII, noon. Tried on Bull 2241 in chupper 24; bit.
8-VIII, noon. Tried on Bull 2243 in chupper 24; bit.
10 VIII, 11 A.M. Tried on bull 2240 in chupper 26; bit.
12-VIII, 11-30 A.M. Tried on Bull 2246 in chupper 29; bit readily.
13-VIII, 5-45 P.M. Crushed and inoculated into Bull 2723. (*Vide* Inoculation experiments.)

Mosquito 45.

23-VII. Found emerged.
28-VII, 12-30 P.M. Tried on Control 2410; bit.
29-VII, 5 P.M. Dissected and examined dark-ground.

Mosquito 46.

24-VII. Found emerged.
3-30 P.M. Enclosed with raisin.
25-VII, 12-30 P.M.—4-30 P.M. Tried repeatedly on Control 2354 (young bull); did not bite.
26-VII, noon and 3 P.M. Tried repeatedly on Control 2436; did not bite.
4 P.M. Removed raisin.
27-VII, 3-30 P.M. Tried on Control 2350; did not bite.
28-VII, 12-30 P.M. Tried on Control 2410; bit.

30-VII, 3 P.M. Tried on Bull 2222 in chupper 53; bit readily.
No raisin given since infective feed.

1-VIII, 11-10 A.M. Tried repeatedly on Bull 2224 in chupper 53; did not bite. Abdomen distended since last feed.

3-VIII. Not tried. Offered raisin.

5-VIII, 9 A.M. Removed raisin.
10-30 A.M. Tried on Bull 2245 in chupper 51; did not bite.

7-VIII, 10-30 A.M. Tried on Bull 2241 in chupper 24; did not bite.

9-VIII, 11-30 A.M. Tried on Bull 2243 in chupper 24; did not bite.

11-VIII, 3 P.M. Tried on Bull 2240 in chupper 26; did not bite.

13-VIII, 8 A.M. Mosquito found dead.

Mosquito 47.

24-VII. Found emerged.
3-30 P.M. Enclosed with raisin.

25-VII, 12-30—4-30 P.M. Tried repeatedly on Control 2354 (young bull); did not bite.

26-VII, noon and 3 P.M. Tried repeatedly on Control 2436; did not bite. Raisin removed.

27-VII, 3-30 P.M. Tried on Control 2350; did not bite.

28-VII, 12-30 P.M. Tried on Control 2410; did not bite.

29-VII, 3 P.M. Tried on Control 2350; bit. Removed raisin.

31-VII, 1 P.M. Tried on Bull 2222 in chupper 53; it seemed to bite, but it could not be definitely ascertained whether it had imbibed blood (abdomen already considerably distended). There was just a suggestion of blood in abdomen.

2-VIII, 2-45 P.M. Tried repeatedly on Bull 2224 in chupper 53; bit, but was not fully gorged.

4-VIII, noon. Tried on Bull 2223 in chupper 51; bit fairly readily and fed very greedily.

6-VIII, 1-30 P.M. Tried on Bull 2245 in chupper 51; did not bite.

8-VIII, 12-15 P.M. Tried on Bull 2241 in chupper 24; did not bite.

10-VIII, 10 A.M. Tried on Bull 2243 in chupper 24; bit.

12-VIII, 10-45 A.M. Tried on Bull 2240 in chupper 26; bit, but was not fully gorged.

13-VIII, 5-45 P.M. Crushed and inoculated into Bull 2723. (*Vide* Inoculation experiments.)

Mosquito 48.

27-VII. Found emerged.
4-30 P.M. Enclosed with raisin.

28-VII, 12-30 P.M. Tried on Control 2410; did not bite. Removed raisin.

29-VII. Not tried.

30-VII, 11-30 A.M. Tried repeatedly and at intervals on Control 2420; bit.
6-30 P.M. Dissected and examined dark-ground.

Mosquito 49.

28-VII, 1 P.M. Found emerged. Enclosed with raisin.
29-VII. Not tried. Raisin not removed.
30-VII, 11-30 A.M. Tried repeatedly and at intervals on Control 2420; bit.
1-VIII, 8 A.M. Removed raisin.
10-40 A.M. Tried on Bull 2222 in chupper 53; bit readily.
3-VIII, 11 A.M. Tried on Bull 2223 in chupper 51; bit. Mosquito escaped.

Mosquito 50.

27-VII, 4-30 P.M. Found emerged. Enclosed with raisin.
28-VII, 12-30 P.M. Tried on Control 2410; did not bite. Removed raisin.
29-VII. Not tried.
30-VII, 11-30 A.M. Tried repeatedly and at intervals on Control 2420; did not bite.
31-VII, 3-45 P.M. Tried on Control 2420; bit.
2-VIII, 1 P.M. Tried on Bull 2222 in chupper 53; bit fairly readily.
3-VIII, 4-45 P.M. Inoculated into Bull 2653. (*Vide* Inoculation experiments.)

Mosquito 51.

28-VII, 1 P.M. Found emerged. Enclosed with raisin.
29-VII, 3 P.M. Not tried.
30-VII, 11-30 A.M. Tried repeatedly and at intervals on Control 2420; did not bite.
31-VII, 3-45 P.M. Tried on Control 2420; did not bite. Raisin not yet removed.
1-VIII, noon. Tried on Control 2420; bit.
3-VIII, 4-15 P.M. Inoculated into Bull 2654. (*Vide* Inoculation experiments.)

Mosquito 52.

27-VII, 4-30 P.M. Found emerged. Enclosed with raisin.
28-VII, 12-30 P.M. Tried on Control 2410; did not bite. Removed raisin.
29-VII, Not tried.
30-VII, 11-30 A.M. Tried repeatedly and at intervals on Control 2420; did not bite.
31-VII, 3-45 P.M. Tried on Control 2420; did not bite.
1-VIII, noon. Tried repeatedly and at intervals on Control 2420; did not bite.
2-VIII, 3 P.M. Tried repeatedly on Control 2412; bit.
3-VIII, 4-22 P.M. Inoculated into Bull 2661. (*Vide* Inoculation experiments.)

Mosquitos 53, 54 and 55.

1-VIII, 2-30 P.M. Enclosed 3 newly-emerged females singly in tubes, with raisins.
2-VIII, 1-30 P.M. Tried on Control 2412; did not bite.
3-30 P.M. Removed raisins.

3-VIII, 3 P.M. Tried on Control 2432 ; did not bite.
4-VIII, 4 P.M. Tried on Control 2441 ; did not bite.
5-VIII, 1 P.M. Tried on Control 2411 ; did not bite.
2 P.M. All the three mosquitos enclosed together in bottle.
6-VIII, 3-30 P.M. Again enclosed the three mosquitos separately in tube.
4-30 P.M. Tried on Control 2441 ; none bit.
7-VIII, noon. Tried on Control 2434 ; all the three bit. Numbered these 53, 54 and 55.

Mosquito 53.

N.B. For previous history see above.

7-VIII, noon. Tried on Control 2434 ; bit.
9-VIII, 12-30 P.M. Tried on Bull 2222 in chupper 53 ; bit.
11-VIII, noon. Tried on Bull 2224 in chupper 53 ; bit fairly readily.
13-VIII, 11 A.M. Tried on Bull 2223 in chupper 51 ; did not bite.
6 P.M. Crushed and inoculated into Bull 2720. (*Vide* Inoculation experiments.)

Mosquito 54.

N.B. For previous history see above.

7-VIII; noon. Tried on Control 2434 ; bit.
9-VIII, 12-30 P.M. Tried on Bull 2222 in chupper 53 ; did not bite.
11-VIII, noon. Tried repeatedly and at intervals on Bull 2224 in chupper 53 ; did not bite.
13-VIII, 11 A.M. Tried repeatedly on Bull 2223 in chupper 51 ; bit.
6 P.M. Crushed and inoculated into Bull 2720. (*Vide* Inoculation experiments.)

Mosquito 55.

N.B. For previous history see above.

7-VIII, Noon. Tried on Control 2434 ; bit.
9-VIII, 12-30 P.M. Tried on Bull 2222 in chupper 53 ; did not bite.
11-VIII, noon. Tried on Bull 2224 in chupper 53 ; did not bite.
13-VIII, 11 A.M. Tried on Bull 2223 in chupper 51 ; did not bite.
6 P.M. Crushed and inoculated into Bull 2720. (*Vide* Inoculation, experiments.)

Mosquitos 56 and 57.

10-VIII 2 P.M. Found emerged. Enclosed two females and one male with raisins in a small bottle.
12-VIII, 12-30 P.M. Removed raisins.
14-VIII, noon. Tried on Control 2461 ; both females bit. The gorged females enclosed separately in tubes as 56 and 57.

Mosquito 56.

N.B. For previous history see above.

16-VIII, 2 P.M. Found dead.

Mosquito 57.

N.B. For previous history see above.

14-VIII, noon. Tried on Control 2461 ; bit. Enclosed with raisin.
16-VIII, 2 P.M. Tried on Bull 2224 in chupper 52 ; did not bite.
18-VIII, 10 A.M. Tried on Bull 2224 in chupper 52 ; did not bite.
4 P.M. Removed raisin.
20-VIII, 10 A.M. Tried on Bull 2224 in chupper 52 ; did not bite.
22-VIII, 10-30 A.M. Tried repeatedly on Bull 2224 in chupper 52 ; bit.
24-VIII, 10-30 A.M. Tried repeatedly and at intervals on Bull 2224 in chupper 52 ; did not bite.
26-VIII, 11 A.M. Tried on Bull 2242 in chupper 53 ; bit.
28-VIII, 11-30 A.M. Tried on Bull 2242 in chupper 53 ; did not bite. Abdomen of mosquito distended with a white mass.
30-VIII, 11 A.M. Tried on Bull 2242 in chupper 53 ; did not bite. Abdomen of mosquito still somewhat distended with a white mass.
1-IX, 4-30 P.M. Mosquito found dead.

Mosquito 58.

20-VIII, noon. Emerged. Enclosed with raisin.
21-VIII, noon. Tried on Control 2688 ; did not bite. Removed raisin.
22-VIII, 1 P.M. Tried repeatedly and at intervals on Control 2602 ; bit.
24-VIII, 10-30 A.M. Tried repeatedly on Bull 2224 in chupper 52 ; bit.
26-VIII, 10-30 A.M. Tried repeatedly and at intervals on Bull 2224 in chupper 52 ; did not bite.
28-VIII, 11 A.M. Tried repeatedly and at intervals on Bull 2224 in chupper 52 ; did not bite. Mosquito suddenly died.

Mosquito 59.

21-VIII, 3-45 P.M. Emerged. Enclosed with raisin.
22-VIII, 1 P.M. Tried on Control 2602 ; did not bite.
3 P.M. Removed raisin.
23-VIII, noon. Tried on Control 2612 ; bit, but was not fully gorged.
25-VIII, 10-30 A.M. Tried on Bull 2224 in chupper 52 ; bit fairly readily, but was not fully gorged.
27-VIII, 10-30 A.M. Tried on Bull 2224 in chupper 52 ; did not bite.
29-VIII, 10-30 A.M. Tried on Bull 2224 in chupper 52 ; bit.
31-VIII, 10-30 A.M. Tried on Bull 2224 in chupper 52 ; bit.

2-IX, 10-30 A.M. Tried on Bull 2224 in chupper 52 ; bit, but was not fully gorged ; Mosquito busy brushing off moisture.
3-IX, evening. Mosquito moribund.
4-IX, morning. Mosquito found dead.

Mosquito 60.

19-VIII, noon. Found emerged.
4 P.M. Enclosed with raisin.
20-VIII, noon. Removed raisin.
21-VIII, noon. Tried on Control 2688 ; did not bite.
22-VIII, 1-2 P.M. Tried repeatedly and at intervals, for a long time, on Control 2602 ; did not bite.
2 P.M. Offered raisin again.
23-VIII, noon. Tried repeatedly and at intervals on Control 2612 ; did not bite. Removed raisin.
24-VIII, 1 P.M. Tried on Control 2612 ; bit.
26-VIII, 10-30 A.M. Tried repeatedly and at intervals on Bull 2224 in chupper 52 ; did not bite.
28-VIII, 11 A.M. Tried repeatedly and at intervals on Bull 2224 in chupper 52 ; bit, but was not fully gorged.
30-VIII, 10 A.M. Tried repeatedly and at intervals on Bull 2224 in chupper 52 ; did not bite.
1-IX, 4-30 P.M. Mosquito found dead.

Mosquito 61.

22-VIII, noon. Found emerged. Enclosed with raisin.
23-VIII, noon. Tried on Control 2612 ; did not bite. Removed raisin.
24-VIII, 1 P.M. Tried on Control 2612 ; bit, but was not fully gorged. Tried several times afterwards, but could not make it take a full feed.
26-VIII, 10-30 A.M. Tried on Bull 2224 in chupper 52 ; bit, but did not take a full feed.
28-VIII, 10 A.M. Tried on Bull 2224 in chupper 52 ; bit very readily.
30-VIII, 10 A.M. Tried repeatedly on Bull 2224 in chupper 52 ; did not bite.
1-IX, 4-30 P.M. Tried on Bull 2224 in chupper 52 ; bit.
3-IX, evening. Mosquito found dead.

Mosquito 62.

25-VIII, 12-45 P.M. Found emerged. Enclosed with raisin.
26-VIII, 1 P.M. Removed raisin.
27-VIII, 3 P.M. Tried on Control 2634 ; did not bite.
28-VIII, 2-30 P.M. Tried on Control 2634 ; did not bite.

29-VIII. Not tried.
30-VIII, 12-30 P.M. Tried on Control 2644; bit.
1-IX, 4-30 P.M. Tried repeatedly on Bull 2224 in chupper 52; did not bite.
3-IX, evening. Mosquito found dead.

Mosquito 63.

7-IX, 4 P.M. Found emerged. Enclosed with raisin.
9-IX, 2 P.M. Removed raisin
10-IX, 4 P.M. Tried on Control 2609; bit.
13-IX. Mosquito found dead.

Mosquito 64.

7-IX, 4 P.M. Found emerged. Enclosed with raisin.
9-IX, 2 P.M. Removed raisin.
10-IX, 4 P.M. Tried on Control 2609; did not bite.
12-IX, 11 A.M.—2 P.M. Tried on Control 2610; bit.
14-IX, 4-30 P.M. Tried on Bull 2224 in chupper 52; did not bite.
15-IX, 11-30 A.M. Ditto. Ditto.
16-IX, 10-30 A.M. Ditto. Ditto.
17-IX, 10-20—11-30 A.M. Tried on Bull 2224 in chupper 52; bit readily.
18-IX, 9-50 A.M. Tried repeatedly on Bull 2224 in chupper 52; bit.
19-IX, 10—11-10 A.M. Tried repeatedly and at intervals on Bull 2224 in chupper 52; did not bite. Abdomen of mosquito distended.
20-IX, 10 A.M. Tried on Bull 2224 in chupper 52; bit readily.
21-IX, 10-11 A.M. Tried on Bull 2224 in chupper 52; could not ascertain whether it had fed, as the day was cloudy and dark and contents of abdomen could not be seen with lens.
22-IX, 10—11-40 A.M. (Weather very chilly and cyclonic.) Tried on Bull 2224 in chupper 52; bit readily.
23-IX. Not tried. Weather very bad and continuous leakage in chupper 52.
24-IX, 10—noon Tried on Bull 2242 in chupper 53; did not bite.
25-IX, 10-30 A.M.—1-30 P.M. Tried on Bull 2242 in chupper 53; did not bite.
26-IX, 10-15 A.M.—11-15 A.M. Tried on Bull 2242 in chupper 53; did not bite.
27-IX, 11-35 A.M.—12-10 P.M. Mosquito very thin. Tried on Bull 2242 in chupper 53; bit.
28-IX, 10-30—11-30 A.M. Tried at intervals on Bull 2242 in chupper 53; bit.
29-IX, 11-35 A.M.—noon. Tried on Bull 2242 in chupper 53; bit readily.
30-IX, 10-30—11-16 A.M. (Weather rainy and dark.) Tried on Bull 2242 in chupper 53; bit (?).
1-X, 10-30—noon. (Weather chilly and windy.) Tried at intervals on Bull 2242 in chupper 53; did not bite. Tried in the open as inside of chupper wet and muddy owing to previous day's rain.

2-X. Not recorded.
3-X, 11-40 A.M.—12-5 P.M. (Weather rainy and somewhat dark.) Tried at intervals on Bull 2631 (young bull) in chupper 54; bit.
4-X, 11-30—11-50 A.M. (Weather somewhat dark.) Tried at intervals on Bull 2631 (young bull) in chupper 54; did not bite.
5-X, 10-30 A.M. (Weather chilly; light changing.) Tried at intervals on Bull 2631 in chupper 54; did not bite.
6-X, 10-21—11-30 A.M. (Weather chilly; light changing.) Tried at intervals on Bull 2631 in chupper 54; did not bite.
7-X, 10-56—11-12 A.M. (Light changing.) Tried at intervals on Bull 2631 in chupper 54; bit.
8-X, 10-37—11-5 A.M. (Light changing.) Tried at intervals on Bull 2631 in chupper 54; bit.
9-X, 10-30—11 A.M. (Light changing.) Tried at intervals on Bull 2631 in chupper 54; did not bite, but made attempts to puncture skin. Bull difficult to immobilize.
10-X, 10-35—11-15 A.M. (Weather chilly, but sunny.) Tried at intervals on Bull 2631 in chupper 54; did not bite.
11-X, 10-36 A.M. Mosquito found dead.

Mosquito 65.

7-IX, 4 P.M. Found emerged. Enclosed with raisin.
9-IX, 2 P.M. Removed raisin.
10-IX, 4 P.M. Tried on Control 2609; did not bite.
12-IX, 11 A.M.—2 P.M. Tried on Control 2610; bit.
14-IX, 4-30—5-30 P.M. Tried on Bull 2224 in chupper 52; bit readily.
15-IX, 10-15—11-30 A.M. Tried at intervals on Bull 2224 in chupper 52; did not bite.
16-IX, 10-30 A.M. Tried on Bull 2224 in chupper 52; bit readily.
17-X, 10-2A.M. Tried on Bull 2224 in chupper 52; bit.
18-IX, 9-50 A.M. Tried on Bull 2224 in chupper 52; bit.
19-IX, 10—11-10 A.M. Tried on Bull 2224 in chupper 52; bit readily.
20-IX, 10 A.M. Tried on Bull 2224 in chupper 52; bit readily. Excreted blood.
21-IX, 10-11 A.M. Tried on Bull 2224 in chupper 52; could not ascertain whether it had fed, as the day was very dark.
22-IX, 10—11-40 A.M. Tried on Bull 2224 in chupper 52; bit. Excreted blood.
23-IX, Not tried. Weather very bad and continuous leakage in chupper.
24-IX Not recorded.
25-IX, 10-30—1 P.M. Tried on Bull 2242 in chupper 53; did not bite.
26-IX, 10-15—11-15 A.M. Tried on Bull 2242 in chupper 53; bit readily.
27-IX, 11-35—12-10, Tried on Bull 2242 in chupper 53; did not bite.

28-IX, 10-30—11-30 A.M. Tried at intervals on Bull 2242 in chupper 53 ; bit readily when tried second time.

29-IX, 11-35 A.M.—noon. Tried on Bull 2242 in chupper 53 ; bit.

30-IX, 10-30—11-16 A.M. (Weather dark and rainy.) Tried on Bull 2242 in chupper 53 ; did not bite.

1-X, 11-30 A.M. Tried at intervals on Bull 2242 in chupper 53 ; did not bite. Tried in the open, as inside of chupper wet and muddy owing to previous day's rain.

2-X, Not recorded.

3-X, 11-40 A.M.—12-5 P.M. (Weather somewhat cloudy.) Tried at intervals on Bull 2631 in chupper 54 ; did not bite.

4-X, 11-30 A.M. Ditto. Ditto.

5-X, 10-30 A.M. (Weather chilly ; light changing.) Tried on Bull 2631 in chupper 54 ; bit readily.

6-X, 10-21—11-30 A.M. (Weather chilly ; light changing.) Tried on Bull 2631 in chupper 54 ; bit.

7-X, 10-56—11-12 A.M. (Light changing.) Tried on Bull 2631 in chupper 54 ; bit, but was not fully gorged.

8-X, 10-37—11-50 A.M. (Weather sunny and chilly.) Tried at intervals on Bull 2631 in chupper 54 ; did not bite.

9-X, 10-30 A.M. (Weather sunny and chilly.) Tried at intervals on Bull 2631 in chupper 54 ; did not bite.

10-X, 10-35—11-15 A.M. (Weather sunny and chilly.) Tried at intervals on Bull 2631 in chupper 54 ; did not bite.

11-X, 10-36 A.M. Mosquito found dead.

Mosquitos 66 to 71.

8-IX, 5 P.M. Nos. 66 and 67 found emerged. Enclosed with raisins singly in tubes.

9-IX, 2 P.M. Raisins removed. Nos. 68, 69, 70 and 71 found emerged. Enclosed singly with raisins.

10-IX, 4 P.M. Raisins removed. Tried Nos. 66 and 67 only on Control 2609 ; did not bite.

12-IX, 11 A.M.—2 P.M. Tried on Control 2610 ; all the six mosquitos bit.

14-IX, 4-30—5-30 P.M. Tried on Bull 2224 in chupper 52. No. 70 bit but was not fully gorged ; No. 71 punctured but did not imbibe blood ; the rest did not bite.

15-IX, 10-15—11-30 A.M. Tried on Bull 2224 in chupper 52. Nos. 66, 69, 70 and 71 did not bite ; No. 68 bit readily ; No. 67 bit when tried at intervals.

16-IX, 10-30 A.M. Tried on Bull 2224 in chupper 52. Nos. 67, 68, 70 and 71 did not bite ; No. 66 bit readily but was not fully gorged ; No. 69 bit readily.

17-IX, 10-30—11-30 A.M. Tried on Bull 2224 in chupper 52. No. 66 did not bite; Nos. 67, 69, 70 and 71 bit readily; No. 68 bit readily but was not fully gorged.

18-IX, 9-50 A.M. Tried on Bull 2224 in chupper 52. Nos. 66, 67, 69 did not bite; No. 71 bit readily; Nos. 68 and 70 bit, but not readily.

19-IX, 10—11-10 A.M. Tried on Bull 2224 in chupper 52. Nos. 68 and 69 did not bite; Nos. 67 and 71 bit readily; No. 70 bit when tried at intervals. No. 66 found dead.

20-IX, 10 A.M. Records obliterated by a downpour of rain whilst the feeding work was being carried on in a chupper.

21-IX, 10-11 A.M. Tried Nos. 67, 68, 69, 70 and 71 on Bull 2224 in chupper 52, but could not ascertain whether they had fed, as the day was dark.

22-IX, 10—11-40 A.M. (Weather chilly and cyclonic.) Tried on Bull 2224 in chupper 52. Nos. 67, 68 and 69 did not bite; Nos. 70 and 71 bit, but not readily.

23-IX. Not tried, as weather extremely bad and continuous leakage in chupper.

24-IX, 8 A.M. No. 69 found dead.

Noon. Tried on Bull 2242 in chupper 53; none bit.

25-IX, noon. Tried on Bull 2242 in chupper 53; none bit.

26-IX, 10-15—11-15 A.M. Ditto.

27-IX, 11-35 A.M.—12-10 P.M. Tried No. 67 on Bull 2242 in chupper 53; did not bite. Nos. 68, 70 and 71 dead.

N.B. The following observations relate to No. 67.

28-IX, 10-30—11-30 A.M. Tried on Bull 2242 in chupper 53; did not bite.

29-IX, noon. Tried on Bull 2242 in chupper 53; did not bite.

30-IX, 10-30—11-16 A.M. (Weather rainy and dark.) Tried on Bull 2242 in chupper 53; did not bite.

1-X, noon. Tried at intervals on Bull 2242 in chupper 53; did not bite. Tried in the open, as interior of chupper wet and muddy.

2-X. Not recorded.

3-X, 11-40 A.M.—12-5 P.M. (Rainy and somewhat cloudy.) Tried at intervals on Bull 2631 in chupper 54; bit.

4-X, 11-30 A.M. (Somewhat cloudy.) Tried at intervals on Bull 2631 in chupper 54; did not bite.

5-X, 10-30 A.M. (Chilly; light changing.) Tried on Bull 2631 in chupper 54 bit readily.

6-X, 10-21—11-30 A.M. (Light changing.) Tried at intervals on Bull 2631 in chupper 54; did not bite.

7-X, 11 A.M. (Light changing.) Tried at intervals on Bull 2631 in chupper 54; did not bite.

8-X, 10-37—11-5 A.M. (Sunny and chilly.) Tried at intervals on Bull 2631 in chupper 54; did not bite.

9-X, 10-30—11 A.M. (Chilly and sunny.) Tried on Bull 2631 in chupper 54; did not bite. Bull difficult to immobilize.

10-X, 10-35—11-15 A.M. (Chilly and sunny.) Tried at intervals on Bull 2631 in chupper 54; did not bite.

11-X, 10-36—11-30 A.M. (Chilly and sunny.) Tried at intervals on Bull 2631 in chupper 54; bit.

12-X, 10-45—11-22 A.M. (Chilly and sunny.) Tried on Bull 2631 in chupper 54; bit, but not readily.

13-X, 10-15—10-45 A.M. (Chilly and sunny.) Tried at intervals on Bull 2631 in chupper 54; bit.

14-X, 10—10-42 A.M. (Chilly and sunny.) Tried at intervals on Bull 2631 in chupper 54; did not bite.

15-X, 10-30 A.M. (Light changing.) Tried on Bull 2631 in chupper 54; did not bite. Fair trial could not be given owing to *gwalla* (cattle-attendant) being bitten by the bull.

16-X, 9-50—10-30 A.M. (Light changing). Tried at intervals on Bull 2631 in chupper 54; bit, but did not take a full feed.

17-X, 9-40—10 A.M. (Sunny and chilly.) Tried at intervals on Bull 2631 in chupper 54; did not bite.

18-X, 10-10—10-50 A.M. (Sunny and chilly.) Tried at intervals on Bull 2631 in chupper 54; did not bite.

19-X, 9-50—10-20 A.M. (Very chilly; light changing.) Tried on Bull 2631 in chupper 54; did not bite. Mosquito fairly active.

20-X, 9-50—10-5 A.M. (Chilly and sunny.) Tried on Bull 2631 in chupper 54; did not bite. Mosquito sluggish.

21-X, 9-25 A.M. Mosquito dead.

Mosquitos 72–76.

9-IX, 2 P.M. No. 72 emerged. Enclosed with raisin.

10-X, 4 P.M. Removed raisin. Nos. 73, 74, 75 and 76 emerged. Enclosed singly in tubes with raisins.

12-IX, 2 P.M. Removed raisins.

13-IX, 11 A.M.—1 P.M. Tried on Control 2610; all bit.

14-IX, 4-30—5-30 P.M. Tried on Bull 2224 in chupper 52. Nos. 72, 73 and 75 did not bite; Nos. 74 and 76 bit readily.

15-IX, 10-15—11-30 A.M. Tried on Bull 2224 in chupper 52. Nos. 75 and 76 bit when tried at intervals (abdomen of No. 76 already distended; the rest did not bite.

16-IX, 10-30 A.M. Tried on Bull 2224 in chupper 52; none bit.

17-IX, 10-20—11-20 A.M. Tried on Bull 2224 in chupper 52. Nos. 72, 73, 75 and 76 did not bite; No. 74 bit readily.

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18-IX, 9-50 A.M. Tried on Bull 2224 in chupper 52. No. 72 moribund (dead short after); No. 74 bit readily; the rest did not bite.

19-IX, 10—11-10 A.M. Tried on Bull 2224 in chupper 52. Nos. 74, 75 and 76 bit readily (abdomen of No. 76 already distended); No. 73 did not bite.

20-IX, 10 A.M. Tried on Bull 2224 in chupper 52. Nos. 73 and 76 bit readily; the rest did not bite although tried at intervals.

21-IX, 10—11 A.M. (Dark and rainy.) Tried on Bull 2224 in chupper 52, but could not ascertain whether any had fed, as the day was dark.

22-IX, 10—11-40 A.M. (Dark, chilly and rainy.) Tried on Bull 2224 in chupper 52. Nos. 74 and 75 bit readily; the rest did not bite.

23 IX. Not tried, as weather extremely bad and continuous leakage in chupper.

24-IX, 10—11-15 A.M. Tried on Bull 2224 in chupper 52. No. 74 bit readily; No. 76 bit readily when tried a second time; the rest did not bite.

25-IX. Not recorded.

26-IX, 10-15—11-15 A.M. Tried on Bull 2242 in chupper 53. No. 74 bit readily; No. 76 bit readily when tried a second time; the rest did not bite, although tried at intervals.

27-IX, 11-35 A.M.—12-10 P.M. Tried on Bull 2242 in chupper 53. No. 76 bit, but not readily; the rest did not bite. No. 73 found dead.

28-IX, 10-30—11-30 A.M. Tried on Bull 2242 in chupper 53. No. 74 punctured, but did not imbibe blood, although tried at intervals; No. 75 did not bite, although tried at intervals. No. 76 moribund.

29-IX, 11-35 A.M.—noon. Tried on Bull 2242 in chupper 53. No. 74 bit readily; No. 75 did not bite.

30-IX, 10-30—11-16 A.M. (Rainy and dark.) Tried on Bull 2242 in chupper 53; none bit.

1-X, 11-30 A.M. (Windy and chilly.) Tried No. 74 at intervals on Bull 2242 in chupper 53; did not bite. Tried in the open using an umbrella to regulate light, as interior of chupper wet and muddy. No. 75 moribund.

2-X, 10-50—11-53 A.M. (Somewhat cloudy.) Tried No. 74 at intervals on Bull 2242 in chupper 53; did not bite. Bull difficult to immobilize. No. 75 dead.

3-X, 11-40 A.M.—12-5 P.M. (Light changing; rainy.) Tried No. 74 on Bull 2631 in chupper 54; did not bite. Mosquito extremely thin and moribund.

Mosquito 77.

11-IX, 3-30 P.M. Enclosed 12 newly-emerged females in a large bottle with raisins.

13-IX, 3-45 P.M. Removed raisins.

14-IX, Not tried.

15-IX. Ditto.

16-IX, noon. Tried on Control 2724; none bit. Enclosed the mosquitos singly in tubes and tried again; one only bit, this being numbered 77.

17-IX, 10-20—11-20 A.M. Tried on Bull 2224 in chupper 52; bit readily.
18-IX, 9-30 A.M. Tried on Bull 2224 in chupper 52; did not bite.
19-IX, 10—11-10 A.M. Tried on Bull 2224 in chupper 52; bit readily.
20-IX, 10 A.M. Tried on Bull 2224 in chupper 52; did not bite.
21-IX, 10—11 A.M. Tried on Bull 2224 in chupper 52, but could not ascertain whether it had fed, owing to insufficient light, as the day was cloudy
22-IX, 10—11-40 A.M. Tried on Bull 2224 in chupper 52; did not bite.
23-IX. Not tried owing to bad weather and leakage in chupper.
24-IX, 10—11-15 A.M. Tried on Bull 2224 in chupper 52; did not feed, but punctured skin.
25-IX, 10-30 A.M.—1 P.M. Tried on Bull 2224 in chupper 52; bit readily when tried a second time.
26-IX, 10-15—11-15 A.M. Tried on Bull 2224 in chupper 52; did not bite.
27-IX, 10-15—11-20 A.M. Tried on Bull 2224 in chupper 52; bit.
28-IX, 10-30—11-30 A.M. Tried on Bull 2242 in chupper 53; did not bite.
29-IX, 11-35 noon. Tried on Bull 2242 in chupper 53; bit readily.
30-IX, 10-30—11-16 A.M. (Cloudy and rainy.) Tried on Bull 2242 in chupper 53; bit readily.
1-X, 11-30 A.M.—noon. (Chilly.) Tried outside under umbrella (as chupper wet and muddy) on Bull 2242, chupper 53; did not bite.
2-X, 11 A.M. (Cloudy.) Tried at intervals on Bull 2242 in chupper 53; did not bite. Bull difficult to immobilize.
3-X, 10-48—11-30 A.M. Tried on Bull 2242 in chupper 53; bit.
4-X, 10-45—11-30 A.M. Tried on Bull 2242 in chupper 53; did not bite, although punctured skin. Abdomen of mosquito already distended.
5-X, 10-30—11-10 A.M. (Cloudy and rainy.) Tried at intervals on Bull 2242 in chupper 53; bit.
6-X, 10-30—11-15 A.M. (Light changing.) Tried on Bull 2631 in chupper 54; did not bite.
7-X, 10-56—11-12 A.M. (Light changing.) Tried at intervals on Bull 2631 in chupper 54; bit.
8-X, 10-37—11-5 A.M. (Light changing.) Tried at intervals on Bull 2631 in chupper 54; punctured, but did not feed. Abdomen of mosquito already distended.
9-X, 10-30—11 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; punctured but did not feed.
10-X, 10-35—11-15 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; bit readily but did not take a full feed.
11-X, 10-36—11-20 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; bit.
12-X, 10-45—11-22 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; punctured but did not feed.
13-X, 10-15—10-45 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; bit.

14-X, 10—10-42 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; punctured but did not feed.

15-X, 10-30 A.M. (Light changing.) Tried at intervals on Bull 2631 in chupper 54; bit, but did not take a full feed.

16-X, 9-50—10-30 A.M. (Light changing.) Tried on Bull 2631 in chupper 54; bit readily.

17-X, 9-40—10 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; did not bite.

18-X, 10-30—10-50 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; bit. Abdomen already distended.

19-X, 9-50—10-20 A.M. (Light changing.) Tried on Bull 2631 in chupper 54; did not bite. Mosquito sluggish.

20-X, 9-50—10-5 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; did not bite.

21-X. Mosquito found dead.

Mosquitos 77 (a) and 84.

11-IX, 3-30 P.M. Enclosed 12 newly-emerged mosquitos in a large bottle with raisins.

13-IX. Removed raisins.

14-IX. Not tried.

15-IX. Ditto.

16-IX, noon. Tried on Control 2724; none bit. Enclosed the mosquitos singly in tubes and tried again on Control 2724; only one bit (No. 77).

17-IX, noon. Tried on Control 2728; one only bit (No. 77 (a)). As the remaining mosquitos looked very sluggish, put them all together in a small bottle with raisins.

18-IX, 11-30 A.M.—1-30 P.M. Tried on Control 2770; none bit, but mosquitos sprightly.

19-IX, noon—1-30 P.M. Tried repeatedly and at intervals on Control 2770; one only bit (No. 84).

Mosquitos 78—83.

12-IX, 5-30 P.M. Enclosed 8 newly-emerged females in a large bottle with raisins.

13-IX, 3-50 P.M. Added 3 more females.

15-IX, 4-30 P.M. Added 1 more female. Changed raisins as they were all covered over with fungus.

17-IX, 4-30 P.M. 1 dead, 1 moribund. Enclosed the rest singly in tubes without raisins.

18-IX, 11 A.M.—2 P.M. Tried on Control 2770; 6 bit. These were numbered 78—83.

19-IX. Not tried as mosquitos still distended with blood.

Mosquitos 77(a), 78, 79, 80, 81, 82, 83 and 84.

For early history see above.

20-IX, 10 A.M. Tried on Bull 2224 in chupper 52. Nos. 77 (*a*), 78, 79, 82, 83 and 84 bit readily; the rest did not bite.

21-IX, 10—11 A.M. Tried on Bull 2224 in chupper 52; No. 78 bit readily, but the rest could not be properly examined owing to insufficient light.

22-IX, 10—11-10 A.M. (Chilly, rainy and cloudy.) Tried on Bull 2224 in chupper 52. No. 77(*a*) bit readily; No. 80 bit, but not readily; No. 81 punctured skin, but did not draw blood; the rest did not bite. Abdomen of Nos. 82 and 83 already distended.

23-IX. Not tried, owing to bad weather and leakage in chupper.

24-IX, 10—11-15 A.M. Tried on Bull 2224 in chupper 52. Nos. 79, 80 and 81 bit readily, but No. 81 drew blood at repeated efforts; No. 82 punctured but did not draw blood; the rest did not bite. Abdomen of Nos. 82 and 83 already distended.

25-IX, 10-30 A.M.—1 P.M. Tried on Bull 2224 in chupper 52. Nos. 80 and 83 bit readily; No. 81 bit but not readily; Nos. 77(*a*) and 78 bit when tried at intervals; the rest did not bite.

26-IX, 11-30 A.M.—1 P.M. Tried on Bull 2224 in chupper 52. No. 83 bit readily. No. 82 bit, but not readily and took a long time to feed; Nos. 78 and 80 bit readily when tried a second time; No. 79 bit, but not readily, when tried at intervals; the rest did not bite.

27-IX, 10-15—11-21 A.M. No. 77 (*a*) dead. Tried the rest on Bull 2224 in chupper 52. Nos. 80 and 82 bit readily; No. 78 bit, but not readily; No. 81 punctured but did not draw blood (? fed slightly); the rest did not bite.

28-IX, 11-30 A.M.—12-23 P.M. Tried on Bull 2224 in chupper 52. No. 84 bit, but not readily; Nos. 80 and 82 punctured skin, but did not draw blood (?No. 82 fed slightly); the rest did not bite. No. 82 excreted blood. Abdomen of No. 80 already distended.

29-IX, 10-15—11-30 A.M. Tried on Bull 2224 in chupper 52. Nos. 78, 83 and 84 bit, but not readily; No. 81 bit when tried at intervals (it took a long time to draw blood and brushed proboscis now and then); the rest did not bite. Abdomen of No. 82 already distended. No. 79 thin and moribund.

30-IX, 11-35—11-45 A.M. (Cloudy.) Tried only No. 84 on Bull 2224 in chupper 52; did not bite. Tried the rest on Bull 2242 in chupper 53; it could not be definitely ascertained whether they had bitten. Abdomen of Nos. 78 and 83 distended. No. 79 still alive, although moribund.

1-X, 11-30 A.M.—Noon. (Cloudy.) Tried (outside, under umbrella, as chupper wet and muddy) on Bull 2242, chupper 53; none bit. No. 79 dead.

2-X, 10-50—11-53 A.M. (Cloudy.) Tried on Bull 2242 in chupper 53. No. 80 bit readily; Nos. 81 and 84 bit, but not readily. Bull difficult to immobilize.

3-X, 10-48—11-30 A.M. (Cloudy.) Tried on Bull 2242 in chupper 53. No. 83 bit readily; No. 81 bit, but not readily; Nos. 80 and 82 bit when tried at intervals; the rest did not bite although tried at intervals.

4-X, 10-45—11-30 A.M. (Sunny.) Tried on Bull 2242 in chupper 53. Nos. 81 and 83 bit readily; No. 78 bit when tried at intervals; No. 82 bit when tried at intervals, but did not take a full feed; No. 80 punctured but did not draw blood; No. 80 would probably have fed but bull became refractory, just at the moment the mosquito was about to bite; No. 84 thin and did not bite.

5-X, 10-30—11-10 A.M. (Cloudy.) Tried on Bull 2242 in chupper 53. No. 78 bit, but not readily; No. 83 bit when tried at intervals; the rest did not bite, although tried at intervals.

6-X, 10-30—11-15 A.M. (Light changing.) Tried at intervals on Bull 2242 in chupper 53; none bit. Abdomen of No. 78 already distended. Nos. 80 and 82 moribund.

7-X, 10-30—10-48 A.M. (Sunny.) Nos. 80, 82 and 83 dead. Tried the rest, at intervals, on Bull 2242 in chupper 53. No. 81 bit readily; No. 84 bit, but not readily; No. 78 did not bite, although tried at intervals.

8-X, 10-37—11-5 A.M. (Sunny.) Tried only No. 84, at intervals, on Bull 2242 in chupper 53; did not bite. Tried the rest on Bull 2631 in chupper 54. No. 81 bit readily; No. 78 bit when tried at intervals.

9-X, 10-30—11 A.M. (Sunny.) Tried on Bull 2631 in chupper 54. Nos. 78 and 81 bit readily (abdomen of No. 81 already distended); No. 84 bit, but not readily.

10-X, 10-35—11-15 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; No. 84 bit but none of the rest bit, although tried at intervals.

11-X, 10-36—11-20 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; No. 78 bit readily, but none of the rest bit although tried at intervals.

12-X, 10-45—11-22 A.M. (Sunny.) Tried on Bull 2231 in chupper 54. Nos. 81 and 84 bit readily, but No. 84 did not take a full feed; No. 78 did not bite, although tried at intervals. Abdomen of No. 78 already distended.

13 X, 10-45—11-45 A.M. (Sunny.) Tried on Bull 2631 in chupper 54. Nos. 78 and 84 bit, but not readily; No. 81 bit readily when tried a second time.

14-X, 10—10-42 A.M. (Sunny.) Tried on Bull 2631 in chupper 54. No. 81 bit, but not readily; No. 78 bit readily when tried a second time; No. 84 did not bite, although tried at intervals.

15-X, 10-30 A.M. (Sunny.) Tried at intervals on Bull 2631 in chupper 54; none bit. A fair trial could not be given.

16-X, 9-50—10-30 A.M. (Light changing.) Tried on Bull 2631 in chupper 54; Nos. 78 and 81 bit when tried at intervals, but No. 81 did not take a full feed. No. 84 moribund.

17-X, 9-40—10 A.M. (Sunny.) Tried on Bull 2631 in chupper 54. No. 81 bit readily; No. 78 did not bite, although tried at intervals. No. 84 dead.

18-X, 10-10—10-50 A.M. (Sunny.) Tried at intervals on Bull 2631 in chupper 54. No. 81 punctured but did not draw blood; No. 78 did not bite, although tried at intervals.

19-X, 9-50—10-30 A.M. (Light changing.) Tried on Bull 2631 in chupper 54. No. 78 bit readily, but did not take a full feed (bull refractory all the time and the mosquito took a long time to draw blood); No. 81 very sluggish, but escaped through torn muslin.

20-X, 9-50—10-5 A.M. (Sunny.) Tried No. 78 on Bull 2631 in chupper 54; did not bite.

21-X. No. 78 dead.

Mosquitos 85, 86 and 87.

17-IX, 4 P.M. Enclosed 7 newly-emerged mosquitos singly in tubes with raisins.

18-IX, 5 P.M. Removed raisins.

19-IX, 11 A.M.—1 P.M. 3 only alive. Tried these on Control 2770; all bit.

21-IX, 10-11 A.M. Tried on Bull 2224 in chupper 52. No. 87, bit readily; the rest could not be properly examined owing to insufficient light as the day was cloudy.

22-IX, 10—11-45 A.M. (Cloudy and rainy.) Tried on Bull 2224 in chupper 52. No. 87 bit readily; the rest did not bite although tried at intervals.

23-IX. Not tried owing to bad weather and leakage in chupper.

24-IX, 10—11-15 A.M. Tried on Bull 2224 in chupper 52. No. 87 bit readily when tried a second time (although its abdomen was already distended); No. 86 tried at intervals and punctured, but did not draw blood; No. 85 did not bite, although tried at intervals.

25-IX, 10-30 A.M.—1 P.M. Tried on Bull 2224 in chupper 52. No. 87, bit readily; the rest did not bite, although tried at intervals.

26-IX, 11-30 A.M.—1 P.M. Tried on Bull 2224 in chupper 52. No. 87 bit readily; No. 86 bit readily when tried a second time; No. 85 did not bite, although tried at intervals.

27-IX, 10-15—11-21 A.M. Tried on Bull 2224 in chupper 52. No. 87 bit readily (although its abdomen was already distended); No. 86 bit, but not readily; No. 85 bit, but not readily.

28-IX, 11-30 A.M.—12-23 P.M. Tried at intervals on Bull 2224 in chupper 52; none bit. No. 85 moribund.

29-IX, 10-15—11-30 A.M. Tried on Bull 2224 in chupper 52. No. 87 bit, but not readily (its abdomen already distended); No. 86 did not bite, although tried at intervals. No. 85 still moribund.

30-IX, 10-35—11-25 A.M. (Cloudy.) Nos. 85 and 86 dead. Tried No. 87 on Bull 2224 in chupper 52; did not feed (? fed slightly).

N.B. The following observations relate to No. 87 only.

1-X, 10-30 A.M. (Cloudy.) Tried on Bull 2224 in chupper 52; did not bite (? fed slightly).

2-X, 10-50—11-53 A.M. (Cloudy.) Tried on Bull 2242 in chupper 53; punctured, but did not draw blood.

3-X, 10-48—11-30 A.M. (Cloudy.) Tried at intervals on Bull 2242 in chupper 52; bit, although abdomen already distended.

4-X, 10-45—11-30 A.M. (Sunny.) Tried at intervals on Bull 2242 in chupper 53; did not draw blood, although punctured skin. Abdomen already distended. Tried again on Bull 2242 after some time; bit.

5-X, 10-30—11-10 A.M. (Cloudy.) Tried at intervals on Bull 2242 in chupper 53; did not bite (? fed slightly.) Abdomen already distended.

6-X, 10-30—11-15 A.M. (Light changing.) Tried on Bull 2242 in chupper 53; punctured, but did not draw blood. Abdomen already distended.

7-X, 10-30—10-48 A.M. (Sunny.) Tried on Bull 2242 in chupper 53; punctured, but did not draw blood. Took a full feed when tried again after a while.

8-X, 10-26—10-35 A.M. (Sunny.) Tried on Bull 2242 in chupper 53; bit readily.

9-X, 10-30—11 A.M. (Sunny.) Tried at intervals on Bull 2631 in chupper 54; did not draw blood, although punctured skin. Abdomen already distended.

10-X, 10-35—11 A.M. (Sunny.) Ditto.

11-X, 10-36—11-20 A.M. (Sunny.) Tried at intervals on Bull 2631 in chupper 54; bit.

12-X, 10-45—11-22 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; bit readily.

13-X, 10-15—10-45 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; bit readily, although took a long time to draw blood.

14-X, 10—10-42 A.M. (Sunny). Tried at intervals on Bull 2631 in chupper 54; punctured every time applied on animal, but did not draw blood.

15-X, 10-30 A.M. (Light changing.) Tried at intervals on Bull 2631 in chupper 54; did not bite. A fair trial could not be given.

16-X, 9-50—10-30 A.M. (Light changing.) Tried at intervals on Bull 2631 in chupper 54; punctured, but did not draw blood. Abdomen already distended.

17-X, 9-40—10 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; bit readily, although abdomen already distended.

18-X, 10—10-50 A.M. (Sunny.) Tried at intervals on Bull 2631 in chupper 54; bit although abdomen already distended.

19-X, 9-50—10-20 A.M. (Light changing.) Tried on Bull 2631 in chupper 54; did not draw blood, although punctured skin. Abdomen already distended.

20-X, 9-50—10 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; bit readily but did not take a full feed. Abdomen already distended.

21-X, 9-25 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; bit readily, although abdomen already distended.

22-X, 10 A.M. (Sunny.) Ditto.

23-X, 10 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; did not bite. Abdomen already distended.

24-X, 10 A.M. (Sunny.) Tried on Bull 2631 in chupper 54; bit readily, although abdomen already distended.

25-X, 10 A.M. (Sunny). Tried on Bull 2631 in chupper 54; punctured, but did not draw blood. Abdomen already distended.

Noon. Mosquito moribund.

1 P.M. Mosquito dead.

Mosquito 88.

19-IX, 4-30 P.M. Emerged. Enclosed with raisin.

21-IX, 2-15 P.M. Removed raisin.

22-IX, 1 P.M. Tried on Control 2982; punctured, but did not draw blood.

24-IX, 3-45 P.M. Tried on Control 2655; bit.

25-IX, 10 A.M.—1 P.M. Tried on Bull 2224 in chupper 52; bit readily when tried a second time.

26-IX, 11-30 A.M.—1 P.M. Tried on Bull 2224 in chupper 52; bit readily, although abdomen already distended.

27-IX, 10-15—11-21 A.M. Tried on Bull 2224 in chupper 52; bit readily.

28-IX, 11-30 A.M.—12-23 P.M. Tried at intervals on Bull 2224 in chupper 52; punctured but did not draw blood. Abdomen already distended.

29-IX, 10-15—11-30 A.M. Tried on Bull 2224 in chupper 52; bit readily.

30-IX, 11-35—11-45 A.M. (Cloudy.) Tried on Bull 2224 in chupper 52; bit, but not readily.

1-X, 10-30—11-30 A.M. (Cloudy and rainy.) Tried at intervals on Bull 2224 in chupper 52; did not bite. Abdomen already distended.

2-X, 10-50—11-53 A.M. (Cloudy.) Tried at intervals on Bull 2224 in chupper 52; did not bite. Bull difficult to immobilize.

3-X, 10-15—11-25 A.M. (Light changing.) Tried on Bull 2224 in chupper 52; bit, but not readily.

4-X, 10-30—10-40 A.M. (Sunny.) Tried on Bull 2224 in chupper 52; bit readily when tried a second time.

5-X, 10—10-24 A.M. (Cloudy.) Tried at intervals on Bull 2224 in chupper 52; bit, although abdomen already distended. It first punctured for sometime without drawing blood.

6-X, 10-30—11-15 A.M. (Light changing.) Tried repeatedly on Bull 2242 in chupper 53; did not bite.

7-X, 10-30—10-48 A.M. (Sunny.) Tried on Bull 2242 in chupper 53 ; bit, but not readily. Abdomen already distended.

8-X, 10-26—10-35 A.M. (Sunny.) Tried on Bull 2242 in chupper 53 ; bit, but not readily. Abdomen already distended.

9-X, 10-25 A.M. (Sunny.) Tried on Bull 2242 in chupper 53 ; bit readily.

10-X, 10-30 A.M. (Sunny.) Tried at intervals on Bull 2242 in chupper 53 ; did not bite. Abdomen already distended.

11-X, 10-30 A.M. (Sunny.) Tried on Bull 2242 in chupper 53 ; bit readily, although abdomen already distended.

12-X. Mosquito dead.

Mosquito 89.

24-IX, 4-30 P.M. Emerged. Enclosed with raisin.

25-IX, 4-45 P.M. Removed raisin.

26-IX, 2 P.M. Tried on Control 2748 ; bit readily.

27-IX, 10-15—11-21 A.M. Tried on Bull 2224 in chupper 52 ; bit readily.

28-IX, 11-30 A.M.—12-23 P.M. Tried on Bull 2224 in chupper 52 ; punctured, but did not draw blood.

29-IX, 10-15—11-30 A.M. Tried on Bull 2224 in chupper 52 ; bit, but not readily.

30-IX, 10-35—11-15 A.M. Tried on Bull 2224 in chupper 52 ; did not bite.

1-X, 10-30—11-10 A.M. (Cloudy and rainy.) Tried on Bull 2224 in chupper 52 ; bit, but not readily.

2-X, 10-30—10-45 A.M. (Cloudy.) Ditto.

3-X, 10-15—10-25 A.M. (Light changing.) Tried at intervals on Bull 2224 in chupper 52 ; did not bite.

4-X, 10-20—10-40 A.M. (Sunny.) Tried on Bull 2224 in chupper 52 ; bit, but not readily.

5-X, 10—10-24 A.M. (Cloudy.) Tried at intervals on Bull 2224 in chupper 52 ; did not bite.

6-X, 10—10-20 A.M. (Light changing.) Tried on Bull 2224 in chupper 52 ; bit when tried a second time, but did not take a full feed.

7-X, 10—10-14 A.M. (Sunny.) Tried on Bull 2224 in chupper 52 ; bit readily.

8-X, 10-26—10-35 A.M. (Sunny.) Tried at intervals on Bull 2242 in chupper 53 ; bit.

9-X, 10-25 A.M. (Sunny.) Tried on Bull 2242 in chupper 53 ; bit readily.

10-X, 10-30 A.M. (Sunny.) Tried on Bull 2242 in chupper 53 ; bit readily.

11-X, 10-30 A.M. (Sunny.) Tried on Bull 2242 in chupper 53 ; punctured, but did not draw blood. Bull refractory.

12-X. Mosquito dead.

Mosquitos 90 and 91.

26-IX, 4-30 P.M. Emerged. Enclosed with raisins singly in tubes.

27-IX, 2 P.M. Raisins not yet removed. Mosquitos kept in a cloth cage ever a basin of water.

28-IX, 1-30 P.M. Mosquitos fairly active.
29-IX, 1-8 P.M. Mosquitos sluggish.
29-IX, 1-48 P.M. Kept in incubator (28°C.).
4-30 P.M. Removed raisins. Kept in incubator (28°C.).
30-IX, 1-50 P.M. Mosquitos happy.
2-30 P.M. (Temperature in room, 13°C.) Tried on Control 2750; one bit readily. This was numbered 90.
2-30 P.M. Tried another at intervals (under identical conditions) on Control 2750; bit. This was numbered 91.

Mosquito 92.

27-IX, 4-20 P.M. Emerged. Enclosed in tube with raisin and kept in incubator.
28-IX, 3 P.M. Mosquito happy.
29-IX, 1 P.M. Ditto.
4-15 P.M. Removed raisin and placed back tube in incubator.
30-IX, 1-50 P.M. Mosquito happy.
3-30 P.M. Tried at intervals on Control 2750; bit.

Mosquitos 90, 91, and 92.

For early history see above.
1-X, 10-30—11-10 A.M. (Cloudy.) Tried on Bull 2224 in chupper 52. Nos. 90 and 92 bit readily when tried a second time; No. 91 bit, but not readily, when tried a second time and did not take a full feed.
2-X, 10-20—10-45 A.M. (Cloudy.) Tried on Bull 2224 in chupper 52. Nos. 91 and 92 bit, but not readily and No. 91 did not take a full feed; No. 90 bit readily when tried a second time.
3-X, 10-20—10-40 A.M. (Sunny.) No. 91 dead. Tried Nos. 90 and 92 at intervals on Bull 2224 in chupper 52; none bit.
4-X, 10-20—10-40 A.M. (Sunny.) Ditto.
5-X, 10—10-24 A.M. (Cloudy.) Ditto.
6-X, 10—10-20 A.M. (Light changing.) Ditto.
7-X, 10—10-14 A.M. (Sunny.) Tried on Bull 2224 in chupper 52; No. 92 bit, but drew blood at repeated efforts (the muslin had to be stretched); No. 90 did not draw blood, but punctured every time it was applied on animal.
8-X, 10-20 A.M. (Sunny.) Tried at intervals on Bull 2224 in chupper 52; none bit.
9-X, 10-10 A.M. Ditto. Ditto.
10-X, 10-10 A.M. (Sunny.) No. 90 dead. Tried No. 92 on Bull 2224 in chupper 52; did not bite.
11-X, 10-15 A.M. (Sunny.) Tried No. 92 on Bull 2224 in chupper 52; bit readily.
12-X, 10-30 A.M. (Sunny.) Tried No. 92 at intervals on Bull 2242 in chupper 53; did not bite.

13-X, Not tried.

14-X, 10 A.M. (Sunny.) Tried No. 92 on Bull 2242 in chupper 53; did not bite. Mosquito moribund.

15-X. No. 92 dead.

Mosquito 93.

10-X, 1-15 P.M. Emerged. Enclosed with raisin, along with 2 more, in a large bottle and kept in incubator (28°C.).

11-X, noon. Mosquitos happy.

2 P.M. Tried on Control 2223; 1 bit readily. This was numbered 93 and was enclosed separately in tube.

2-5 P.M. The mosquito was carried about from place to place (being kept in pocket close to the person) during field work.

5 P.M. Mosquito found dead.

Mosquito 94.

13-X, 3 P.M. Enclosed 2 newly-emerged mosquitos in bottle with raisins and kept in incubator (28°C.).

14-X, 11-30 A.M. Both happy.

12-30 P.M. Tried on Control 2246 for a long time; did not bite.

15-X, 1-30 P.M. Tried on Control 2246; 1 only bit. This was enclosed separately in tube and numbered 94.

16-X and 17-X. Not tried.

18-X, 10—10-15 A.M. Tried at intervals on Bull 2224 in chupper 52; did not bite.

19-X. Mosquito dead.

Mosquito 95. (*One of the two mosquitos enclosed along with No. 93 on 10-X.*)

11-X. Tried on Control 2223; did not bite. Enclosed mosquito in a large bottle with raisins, and kept in incubator (28°C.).

12-X, 1-37 P.M. Mosquito happy.

13-X, 3 P.M. Ditto.

14-X, 11-30 A.M. Changed raisins as they were covered over with fungus.

12-30 P.M. Tried for a long time on Control 2246; did not bite.

15-X, 1-30 P.M. Tried repeatedly and at intervals on Control 2246; did not bite. Enclosed mosquito in tube, without raisin, and kept tube inverted over moist filter paper in incubator.

16-X, 3-22 P.M. Mosquito happy.

17-X, 10-49 A.M. Ditto.

18-X, 12-30 P.M. Tried at intervals on Control 2440; bit.

19-X, 9-30—9-45 A.M. (Sunny.) Tried on Bull 2224 in chupper 52; bit readily, although abdomen distended.

20-X. Mosquito found dead.

Mosquito 96. (*The mosquito enclosed along with No. 94 on 13-X.*)

15-X, 1-30 P.M. Tried repeatedly and at intervals on Control 2246; did not bite. Enclosed mosquito in tube without raisin, and kept tube inverted over moist filter paper in incubator.

16-X, 3-30 P.M. Mosquito happy.

17-X, 10-48 A.M. Ditto.

12-30 P.M. Tried at intervals on Control 2440; bit.

Mosquito 97.

15-X. 1-30 P.M. Enclosed 4 females and 1 male in a large bottle, with raisins, in incubator.

16-X, 3-28 P.M. All happy. Changed raisins as they were covered over with fungus.

17-X, 11 A.M. Male dead; the rest happy. No fungus on raisins yet.[1]

12-30 P.M. Enclosed the mosquitos singly in tubes and tried on Control 2440; 1 bit readily. This was numbered 97.

Mosquitos 96 and 97.

For early history see above.

18-X, 10—10-15 A.M. (Sunny.) Tried on Bull 2224 in chupper 52. No. 96 bit, but not readily; No. 97 did not bite, although tried at intervals.

19-X, 9-30—9-45 A.M. (Sunny.) Both the mosquitos very sluggish (apparently due to very low atmospheric temperature) and still distended with blood imbibed during their initial feed. Tried on Bull 2224 in chupper 52. No. 96 bit readily; No. 97 did not bite. Mosquitos regained activity shortly after being placed in contact with animal.

20-X. Both mosquitos dead.

Mosquitos 98, 99 and 100.

(*These were the three mosquitos enclosed with No. 97 on 15-X.*)

17-X, 11 A.M. All happy, but male dead.

12-30 P.M. Enclosed the mosquitos, singly, in tubes and tried on Control 2440; did not bite. Kept mosquitos in incubator.

18-X, 1 P.M. Not tried.

19-X, noon. Tried on Control 2627; all bit. Kept them in incubator without food, the tubes being kept inverted over moist filter paper.

22-X, 12-30 P.M. All happy.

23-X, 10-30 A.M. One dead; the rest happy.

14-X. 10 A.M. The other two dead.

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[1]The relevancy of these remarks arises from the fact that the raisins (offered to the mosquitos to feed upon) were very quickly covered over with fungus when placed in the incubator, as compared with what occurred under the ordinary atmospheric conditions at Muktesar.

Mosquitos 101 and 102.

17-X, 1-12 P.M. Emerged. Enclosed, singly, in tubes, with raisins. Kept tubes inverted over moist filter paper in incubator.
18-X, 1 P.M. Both happy.
19-X, noon. Both happy. Tried on Control 2627; did not bite.
1-29 P.M. Removed raisins.
21-X, 10-20 A.M. Both happy.
11 A.M. Tried on Control 3181; both bit. These were numbered 101 and 102. Placed No. 101 in incubator over moist filter paper. No. 102 was kept in cupboard over moist muslin in room temperature.
22-X, 12-22 P.M. Mosquito in incubator quite active; that in cupboard very sluggish.
23-X, 10-30 A.M. Ditto. Ditto.
24-X, 10-12 A.M. Ditto. Ditto.
Enclosed both together in a large bottle with moist filter paper and raisins and kept bottle in incubator.
25-X, 11 A.M. Both happy.
26-X, 4 P.M. Both happy.
27-X, 2 P.M. Both happy. Changed raisins as they were mouldy.
28-X, 11-30 A.M. Both happy.
29-X, noon. Both happy. Enclosed the two singly in tubes.
3-30 P.M. Tried on Bull 2224 in chupper 52; only 1 bit, but not readily and did not take a full feed. The mosquitos became extremely sluggish when taken out of the incubator (the day was cloudy and very chilly).

Experiments discontinued.

As will be seen from the foregoing, the feeding experiments may be divided into two series :—

Series I (1-VI to 13-VIII). There were 18 experimental bulls divided into two lots of 15 and 3. The mosquitos were tried on bulls of the first lot every 2 days since the date of infective feed, and every 4 days on bulls of the second lot, a mosquito being tried only one day on the same bull.

Series II (14-VIII to 29-X). There were only 3 experimental bulls—Nos. 2224, 2242, and 2631. Each mosquito was tried on Bull 2224 up to the 11th day from the date on which it sucked infected blood. From the 12th to the 19th day it was tried on Bull 2242, and from the 20th day onward, on Bull 2631. But here again, the feeding experiments may be divided into two categories :—

1 (14-VIII to 14-IX). The mosquitos were tried on bulls every 2 days.
2 (15-IX to 29-X). The mosquitos were tried on bulls every day.

Where a deviation from the above rules has occurred, or where a mosquito died during the progress of an experiment, the fact has been indicated in the protocols.

The feeding experiments may therefore be tabulated as follows (the tables show the frequency with which each mosquito bit)[1] :—

[1]All bulls were subsequently found on testing to have been actually susceptible to rinderpest.

Table of feeding experiments on bulls.

Series

Number of experimental animal.	Mosquito 1	Mosquito 2	Mosquito 5	Mosquito 6	Mosquito 8	Mosquito 10	Mosquito 11	Mosquitos 12 *	Mosquitos 13*	Mosquito 14	Mosquitos 14 (a)**	Mosquito 15
2322	—	—	—	—	—	—	—	—	+ +	—	—	—
2224	—	+	—	+	—	Dead	—	—	+	+	—	—
2223	—	—	+	+	—	..	+	+	+ one dead	—	+	—
2245	—	+	—	+	—	..	—	—	+	+	+	—
2241	+	—	—	+	—	..	—	—	—	—	+	—
2243	—	+	—	+	—	..	+	—	+	+	Not tried	—
2240	—	Moribund	—	+	—	..	—	—	—	Dead	Not tried	Dead
2246	—	Dead	—	+	Dead	..	—	—	Not tried	..	—	..
2242	—	..	+	+	..	..	Dead	Dead	+	..	—	..
2244	—	..	+	+	..	..	..	..	—	..	+ +	..
2348	..	..	—	—	..	..	..	..	Dead	..	+ +	..
2627	..	..		..	..	..	..	..	..	..	..	..
2346	..	..	Not tried		..	..	..	..	..	..	+	..
2626	..	..			..	..	..	..	..	..	..	..
2349	..	..	—	—	..	..	..	..	..	..	—	..
2599	..	..	..	..	..	..	..	..	..	..	..	..
2351	..	..	+	—	..	..	..	..	..	..	+	..
2347	..	..	+	..	..	..	..	..	..	..	+	..
2614	..	..	..	..	..	..	..	..	..	..	..	..
2623	..	..	..	..	..	..	..	..	..	..	..	..
2440	..	..	+	Dead	..	..	..	..	..	..	+	..
2442	..	..	+	..	..	..	..	..	..	..	Dead	..
2631	..	..	..	..	..	..	..	..	..	..	..	..
2439	..	..	Dead	..	..	..	..	..	..	..	..	..
2678	..	..	..	..	..	..	..	..	..	..	..	..

* Two mosquitos enclosed
** See schedule of experi

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I.

Mosquitos 15 (a)**	Mosquito 16	Mosquitos 17 *	Mosquito 18	Mosquito 19	Mosquito 20	Mosquito 21	Mosquito 22	Mosquito 23	Mosquito 24	Mosquitos 25 *	Mosquito 27	Mosquito 28	Mosquito 29	Mosquito 30	Mosquito 31
Not tried	—	—	—	+	—	+	+	+	—	—	+	+	+	+	+
..	+	+	—	Not tried	Dead	+	+	+	+	+	+	+	Dead	+	+
..	Not tried	Not tried	Not tried	+	..	+	+	+	+	+ +	—	+	..	+	+
—	+	+ one dead	+	—	..	+	+	Dead	+	Dead	Dead	+	..	+	Dead
—	—	—	Dead	Dead	..	+	—	..	—	..	..	+	..	Dead	..
Not tried	—	+	..	..	..	+	+	..	+	..	..	Dead	..	..	..
—	+	—	..	..	..	—	Dead	..	+	..	..	..	..	..	..
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—	? +	Dead	..	..	..	Dead	..	..	Dead	..	..	..	..	..	..
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in one tube.
ments for explanation.

Series

Number of experimental animal	Mosquito 32	Mosquito 33	Mosquito 34	Mosquito 35	Mosquito 36	Mosquito 37	Mosquito 38	Mosquito 39
2222	+	—	+	+	+	+	+	+
2224	+	+	+	+	+	+	Damaged	+
2223	—	Dead	+	+	+	+	..	+
2245	—	..	Dead	+	—	—	..	—
2241	Dead	..	..	+	—	—	..	—
2243	..	..	..	—	Dead	—	..	—
2240	..	..	..	—	..	—	..	—
2246	..	..	..	+	..	—	..	Dead
2242	..	..	..	+	..	—	..	..
2244	..	..	..	—	..	—	..	..
{2348	..	..	..	—	..	..	..	..
2627}	..	..	..	..	..	—	..	..
{2346	..	..	..	..	..	..	..	..
2626}	..	..	..	+	..	—	..	..
{2349	..	..	..	..	..	..	..	..
2599}	..	..	..	—	..	—	..	..
2351	..	..	..	—*	..	Moribund	..	..
{2347	..	..	..	Inoculated into Bull 2723	..	..	..	..
2614	..	..	..		..	..	..	..
2623}	..	..	..		..	..	..	..
2440	..	..	..		..	..	..	..
{2442	..	..	..		..	..	..	..
2631}	..	..	..		..	..	..	..
{2439	..	..	..	..	..	..	..	..
2678}	..	..	..	..	..	..	..	..

* This observation is shown against Bull 2462

I—continued.

Mosquito 40	Mosquito 41	Mosquito 42	Mosquito 43	Mosquito 44	Mosquito 46	Mosquito 47	Mosquito 49	Mosquito 50	Mosquito 53	Mosquito 54	Mosquito 55
+	+	—	+	+	+	? +	+	+	+	—	—
+	+	—	+	+	—	+	..	Inoculated into Bull 2653.	+	—	—
+	—	—	+	+	Not tried	+	+		—	+	—
—	—	—	—	+	—	—	Escaped		Crushed and inoculated into Bull 2720.	Crushed and inoculated into Bull 2720.	Crushed and inoculated into Bull 2720.
+	—	+	+	+	—	—	..				
—	—	—	Dead	+	—	+	..				
—	—	—	..	+	—	+	..				
+	Dead	+	..	+	Dead	Crushed and inoculated into Bull 2723.	..				
+	..	+	..	Crushed and inoculated into Bull 2723.	..		..				
—	..	+	..		..		..				
..	..	Crushed and inoculated into Bull 2723.	..		..		..				
—	..		..		..		..				
Dead	..		..		..		..				
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in schedule of experiments. See against date 11—VIII).

Series

No. of animal	Days	Mosquito 57	Mosquito 58	Mosquito 59	Mosquito 60	Mosquito 61	Mosquito 62
No. 2224	2nd day . .	—	+	+	—	+	—
	4th day . .	—	—	—	+	+	Dead
	6th day . .	—	—	+	—	—	..
	8th day . .	+	Dead	+	Dead	+	..
	10th day . .	—	..	+	..	Dead	..
No. 2242	12th day . .	+	..	Dead	..	..	..
	14th day . .	—	..	..	..	..	..
	16th day . .	—	..	..	..	..	..
	18th day . .	Dead	..	..	..	..	..
No. 2631	20th day . .	..	..	..	..	..	..
	22nd day . .	..	..	..	..	..	..
	24th day . .	..	..	..	..	..	..
	26th day . .	..	..	..	..	..	..
	28th day . .	..	..	..	..	..	..
	30th day . .	..	..	..	..	..	..

Series

No. of animal	Days	Mosquito 64	Mosquito 65	Mosquito 66	Mosquito 67	Mosquito 68	Mosquito 69	Mosquito 70	Mosquito 71	Mosquito 72	Mosquito 73	Mosquito 74	Mosquito 75	Mosquito 76
No. 2224	1st day	Continued from last series								—	—	+	—	+
	2nd day	..	..	..	..	..	..	..	..	—	—	—	+	+
	3rd day	—	—	—	+	+	—	—	—	—	—	—	—	—
	4th day	—	+	+	—	—	+	—	—	—	—	+	—	—
	5th day	+	—	—	+	+	+	+	+	D.	—	+	—	—
	6th day	+	+	—	—	+	—	+	+	..	—	+	+	+
	7th day	—	+	D.	+	—	—	+	+	..	+	—	—	+
	8th day	+	+	Records illegible (See under date 20-IX)						..	?	?	?	?
	9th day	?+	?+	..	?	?	?	?	.	..	—	+	+	—
	10th day	+	+	..	—	—	N.T.	+	+	..	N.T.	N.T.	N.T.	N.T.
	11th day	N.T.	N.T.	..	N.T.	N.T.	N.T.	N.T.	N.T.	..	—	+	—	+

II. (*1*)

Mosquito 64	Mosquito 65	Mosquito 66	Mosquito 67	Mosquito 68	Mosquito 69	Mosquito 70	Mosquito 71
—	+	—	—	—	—	+	—
Continued to next series.	Continued to next series.	Continued to next series.	Continued to next series.	Continued to next series.	Continued to next series.	Continued to next series.	Continued to next series.

II. (*2*)

Mosquito 77	Mosquito 77(a)	Mosquito 78	Mosquito 79	Mosquito 80	Mosquito 81	Mosquito 82	Mosquito 83	Mosquito 84	Mosquito 85	Mosquito 86	Mosquito 87	Mosquito 88	Mosquito 89	Mosquito 90	Mosquito 91	Mosquito 92	Mosquito 94	Mosquito 95	Mosquito 96	Mosquito 97	Mosquito 101	Mosquito 102
+	N.T.	N.T.	N.T.	N.T.	N.T.	N.T.	N.T.	+	N.T.	N.T.	N.T.	+	+	+	+	+	N.T.	+	+	—	N T.	N.T.
—	N.T.	+	+	—	—	+	+	?	?	?	+	+	—	+	+	+	N.T.	D.	+	—	N.T	N.T.
+	+	+	?	?	?	?	?	—	—	—	+	+	+	—	D.	—	—	..	D.	D.	N.T.	N.T.
—	?	—	—	+	—	—	—	N.T.	N.T.	N.T.	N.T.	—	—	—	..	—	D.	..	..	..	N.T.	N.T.
?+	+	N.T.	N.T.	N.T.	N.T.	N.T.	N.T.	—	—	—	—	+	+	—	..	—	..	..	..	..	N.T.	N.T.
—	N.T.	—	+	+	+	—	—	—	—	—	+	+	+	—	..	—	..	..	..	..	N.T.	N.T.
N.T.	—	+	—	+	+	—	+	—	—	+	+	—	—	—	..	+	..	..	..	..	N.T.	N.T.
—	+	+	+	+	—	+	+	—	+	+	+	—	+	—	..	—	..	..	..	..	+	—
+	—	+	—	+	?+	+	—	+	M.	—	—	+	—	—	..	—	..	..	..	..	Discontinued	Discontinued
—	D.	—	—	—	—	?+	—	+	M.	—	+	+	+	D.	..	—	..	..	..	..		
+	..	+	M.	—	+	—	+	—	D.	D.	?+	+	+	..	..	+	..	..	..	..		

Series

No. of Animal	Days	Mosquito 64	Mosquito 65	Mosquito 66	Mosquito 67	Mosquito 68	Mosquito 69	Mosquito 70	Mosquito 71	Mosquito 72	Mosquito 73	Mosquito 74	Mosquito 75	Mosquito 76
No. 2242	12th day	—	N. R.	..	—	—	D.	—	—	..	N.R.	N.R.	N.R.	N.R.
	13th day	—	—	..	—	—	..	—	—	..	—	+	—	+
	14th day	—	+	..	—	—	..	—	—	..	D.	—	—	+
	15th day	+	—	..	—	D.	..	D.	D.	..	..	—	—	M.
	16th day	+	+	..	—	..	..	..	..	..	..	+	—	..
	17th day	+	+	..	—	..	..	..	.	..	..	—	—	..
	18th day	?+	—	..	—	..	..	..	..	..	..	—	M.	..
	19th day	—	—	..	—	..	..	..	..	..	..	—	D.	..
No. 2631	20th day	N.R.	N.R.	..	N.R.	..	..	..	..	..	..	M.	..	..
	21st day	+	—	..	+	..	..	..	..	..	..	..	..	..
	22nd day	—	—	..	—	..	..	..	..	..	..	..	..	..
	23rd day	—	+	..	+	..	..	..	..	..	..	..	..	..
	24th day	—	+	..	—	..	..	..	..	..	..	..	..	..
	25th day	+	+	..	—	..	..	..	..	..	..	..	..	..
	26th day	+	—	..	—	..	..	..	..	..	..	..	..	..
	27th day	—	—	..	—	..	..	..	..	..	..	..	..	..
	28th day	—	—	..	—	..	..	..	..	..	..	..	..	..
	29th day	D.	D.	..	+	..	..	..	..	..	..	..	..	..
	30th day	..	..	..	+	..	..	..	..	..	..	..	..	..
	31st day	..	..	..	+	..	..	..	..	..	..	..	..	..
	32nd day	..	..	..	—	..	..	..	..	..	..	..	..	..
	33rd day	..	..	..	—	..	..	..	..	..	..	..	..	..
	34th day	..	..	..	+	..	..	..	..	..	..	..	..	..
	35th day	..	..	..	—	..	..	..	..	..	..	..	..	..
	36th day	..	..	..	—	..	..	..	..	..	..	..	..	..
	37th day	..	..	..	—	..	..	..	..	..	..	..	..	..
	38th day	..	..	..	—	..	..	..	..	..	..	..	..	..
	39th day	..	..	..	D.	..	..	..	..	..	..	..	..	..

"N.R." signifies " result
"N.T." signifies " not
"M" " that
"D." " "
"E." " "

II. (*2*)—contd.

Mosquito 77	Mosquito 77 (*a*)	Mosquito 78	Mosquito 79	Mosquito 80	Mosquito 81	Mosquito 82	Mosquito 83	Mosquito 84	Mosquito 85	Mosquito 86	Mosquito 87	Mosquito 88	Mosquito 89	Mosquito 90	Mosquito 91	Mosquito 92	Mosquito 94	Mosquito 95	Mosquito 96	Mosquito 97	Mosquito 101	Mosquito 102
—	..	?	M.	?	?	?	?	—	..	..	?+	—	+	..	..	—	..	..	..	..	..	..
+	..	—	D.	—	—	—	—	+	..	..	—	+	+	..	..	N.T.	..	..	..	..	..	..
+	..	—	..	+	+	—	—	—	..	..	+	+	+	..	..	M.	..	..	..	..	..	..
—	..	—	..	+	+	+	+	—	..	..	+	+	—	..	..	D.	..	..	..	..	..	..
—	..	+	..	—	+	+	+	—	..	..	?+	—	D.	..	..	..	..	..	..	..	..	..
+	..	+	..	—	—	—	+	—	..	..	—	+	..	..	..	..	..	..	..	..	..	..
—	..	—	..	M.	—	M.	—	+	..	..	+	D.	..	..	..	..	..	..	..	..	..	..
+	..	—	..	D.	+	D.	D.	—	..	..	+	..	..	..	..	..	..	..	..	..	..	..
—	..	+	..	..	+	..	..	+	..	..	—	..	..	..	..	..	..	..	..	..	..	..
+	..	+	..	..	+	..	..	+	..	..	—	..	..	..	..	..	..	..	..	..	..	..
—	..	—	..	..	—	..	..	—	..	..	+	..	..	..	..	..	..	..	..	..	..	..
—	..	+	..	..	—	..	..	+	..	..	+	..	..	..	..	..	..	..	..	..	..	..
+	..	—	..	..	+	..	..	+	..	..	+	..	..	..	..	..	..	..	..	..	..	..
+	..	+	..	..	+	..	..	—	..	..	—	..	..	..	..	..	..	..	..	..	..	..
—	..	+	..	..	+	..	..	—	..	..	—	..	..	..	..	..	..	..	..	..	..	..
+	..	—	..	..	—	..	..	M.	..	..	—	..	..	..	..	..	..	..	..	..	..	..
—	..	+	..	..	+	..	..	D.	..	..	+	..	..	..	..	..	..	..	..	..	..	..
+	..	—	..	..	+	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
+	..	—	..	..	—	..	..	..	..	..	—	..	..	..	..	..	..	..	..	..	..	..
—	..	+	..	..	E.	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
+	..	—	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
—	..	D.	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
—	..	..	..	..	..	..	..	..	..	..	—	..	..	..	..	..	..	..	..	..	..	..
D.	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	D.	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

not recorded."
tried."
the mosquito was moribund
" " " dead.
" " " escaped.

The feeding experiments on rabbits.

History of mosquitos that were fed on rabbits.

Mosquito 1. 27-VIII, 3 P.M. Emerged. Enclosed with raisin.
29.-VIII, 4 P.M. Removed raisin.
30-VIII, 3-4 P.M. Tried on two Two-day-strain Rabbits (on ears); mosquito punctured, but did not draw blood.

Mosquito 2. 28-VIII, noon. Emerged. Enclosed with raisin.
29-VIII, 4 P.M. Removed raisin.
30-VIII, 3-4 P.M. Tried on ears of two Two-day-strain Rabbits; mosquito punctured, but did not draw blood.

Mosquitos 3—10. 29-VIII. Emerged. Enclosed singly in tubes, with raisins.
30-VIII. Removed raisins.

Mosquitos 11—21. 30-VIII. Emerged. Enclosed singly in tubes, with raisins.
31-VIII. Removed raisins.

Mosquitos 22—27. 31-VIII. Emerged. Enclosed singly in tubes, with raisins.
1-IX, afternoon. Removed raisins.

Mosquitos 28—30. 1-IX. Emerged. Enclosed with raisins singly in tubes.
2-IX. Removed raisins.

Mosquitos 1—22. 1-X, 10-30 A.M.-2-30 P.M. Tried on Two-day-strain Rabbit 1995. No. 16 bit, but was not fully gorged; No. 22 did not bite; all the rest, except No. 6 (which was dead), were fully gorged.

Mosquitos 22—30. 3-IX. Tried on Two-day-strain Rabbit 2009 (2010?) (rabbit moribund); none bit.

Mosquitos 22—30. 3-IX, 11 A.M.-1 30 P.M. Tried on Two-day-strain Rabbit 1995; all were fully gorged.

The results of the feeding experiments are tabulated. The table shows the behaviour of each mosquito during feeding from day to day.

"a" indicates that the abdomen of the mosquito was already distended; "f" indicates that the mosquito bit, but was not fully gorged; "ff" indicates that the mosquito took a full feed; "i" represents that the mosquito was tried on the animal at intervals; "n" signifies that the mosquito was tried, but did not bite; "p" indicates that the mosquito punctured but did not draw blood; "r" signifies that that mosquito bit readily.

The feeding on normal rabbits was commenced on 3-IX. and terminated on 8-X. After that date the surviving mosquitos were tried on bulls, on account of the high mortality amongst the experimental rabbits, caused by hæmorrhagic septicæmia.

Table showing biting propensities of A. (S.) albopicta.

Table showing biting propen

Rabbit or Bull No.	Date	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18
	3	f	ff	ff		f		ff	f	ff	n a	ff	ff	ff a	n a	ff	ff	ff	f a
	4	Not tried				..		Not tried			ff	Not tried			ff	Not tried			
Rabbit 2042.	5	ff	ff a	f		ff		ff	ff	ff	n a	ff	ff a	ff	n a	n	f a	ff	ff
	6	n a	n a	n a		ff		n a	n a	n a	fp a	n a	ff a	f a	ff	n	n	n a	n a
	7	ff	n	ff		f i		ff	ff	n	ff	ff	ff	ff i	ff		ff	ff	n
	8	n	ffr	np		ff		fl	n	ff r	flr	n p	ff a	n	{n a		np	np	f i
	9	ffr	ffr			ffr		ff r	ffr	n i	n ai	ffr	ffr a	ff	ff		ff r	f	n i
Rabbit 2043.	10	ffr	ffr			fla i		ffr a	ff	n i	ffr	n a	ff a	ffr	f a		ff i	ff	f
	11	n a i	n a i			n i		ff r	n a i	f	ff a i	n a i	ff a	ff a	n i		n a i	n	ffr
	12	ff i	n a i			f		ff r	ff	fl r	f a	ff a i	ffr a	f	fl		ffr	ffr	ni
	13	n a i	n a i			f		ff i	n	ff r	ff i	np a	ffr a	ni	ff		ff a i	ff i	n i
	14	n i	ff i		Killed	ff		n i	ffr	n i	fi	n i	ff	fi	n i		ffr a	n i	n i
Rabbit 2210.	15	n i	ffr				Dead	ff r	fr a	n i	n a i	n i	na i	ffr	fi		ff a	ff i	fi
	16	ff	ff					np a i	n i	np i	np a i	ff	ffr	n i	n i		ffr	n i	ffr
	17	n i	f a	Dead				f i	ffr	f	n i	n a i	n a i	n i	fl r	Dead	np i	f	
	18	ffi a	ffi					ff i	n a i	n i	f	n i	n i	n i	n i		ff i	ff	
	19	n i	ff a i					ff i	n i	ffi	ffr	n i	ff	f	ffr		np i	n i	
Rabbit 2301.	20	n i	n i			Dead		np i	ff	n i	n i	n i	n a i		n a i		f	f i	
	21	np i	np i					np i	ff	n i	np i	n i	ff a		n i		ff	n i	
	22	np i	ff i					ff	n i	ff i	ff	ff i	ff a		n i		f i	ff i	Dead
	23	fr	ff i					n a i	n i	fr	np a i	n a i	ffp a i	Dead	ffr		n i	ff i	
	24	n i	ffr a					ffr a	fr	ffi	ff	n a i	np a i				f	ff i	
Rabbit 2312.	25	np i	np i					ff a	ff i	n i	ff a	n i	ff i				fl	fl	
	26	fr						ffa i	ffr	n i	n a i	ff	ffr		Dead		ffi	ni	
	27	n i	Dead					ff a	f i	ff	n i	n i	f a				f	Dead	

N.B. When "P" occurs with "f" or "ff," it indicates that for a while the mosquito punctured the

sities of A. (S.) albopicta.

No. 19	No. 20	No. 21	No. 22	No. 23	No. 24	No. 25	No. 26	No. 27	No. 28	No. 29	No. 30	Time of experiment and condition of weather
n a	n a	ff	Not tried									2—5 P.M.
ff	ff a	Not tried										2-30—3 P.M.
ff	n a	ff	ff	ff	ff	ff	ff	ff	ff	ff a	ff	10-30 A.M.—2-30 P.M.
n a	ff	ff a	ff a	n a	n a	n a	n a	np a	np a	n	np a	11-45 A.M.—2-20 P.M.
ff i	n	n	n	n	f r i	ff	n	ff	ff	fr	ffr	10-20 A.M.—1-20 P.M.
ffi	ffr	ffr	ff	n i	ffr	n a	ffr	np a	n a	ff i	f	11 A.M.—1-30 P.M.
n a	n a i	ff	f	ffi	ffr	ffr a	ffr a	ffr	ff	f	ffr	10-50 A.M.—1 P.M.
ff a	ffr	n a i	ff	n a i	ff	ff a	n a	ffr	ff	ffr	ff i	10-50 A.M.—1-45 P.M.
ff a i	n a i	ffr	f a i	ffi	n a i	n a i	n i	ffr a	ff a	ff a i	f a	11 A.M.—2 P.M.
ffr	np a	n i	ff i	n a	ffr	ffr	ff i	n a	n a	ff	n i	2-35—4-50 P.M.
n i	n a i	f	np a	ff	np a i	ffr	ff	ffr	fr a	n i	ff	1-25- 3-25 P.M.
ff	ffr	ff	fi	n i	ffi	n a i	np a i	n a i	ff a	ff i	ffr	1—3-30 P.M.
np a i	n a i	np i	np i	np i	ffr a	ffr a	n pai	n a i	np a i	np a i	ffr a	3-30—5-15 P.M.
ff a	n i	Dead	ffp i	ff	ffr	np a i	ff	np i	ffr	ffi	n a i	1-30—3 P.M.
n i	ffr	..	n i	Dead	ffr a	np i	n a i	Dead	np a i	f i	np i	1-20—3-11 P.M.
ffr	n i	..	n i	..	ffa	Dead	n i	..	ffp a i	n i	n p a i	2-30—[illegible]-21 P.M.
n i	n i	..	ffr	..	ffr a	..	ffr	..	ffr a	fr	ffr	2-30—3-50 P.M.
fr	fr	..	ff i	..	np a i	..	n a i	..	ffp a i	n i	ff	1-30—3-7 P.M.
fi	n a i	..	np i		ffr	..	ffi	..	ffr	n i	ffr	12-15—1-50 P.M.
n i	n i	..	n i	..	np a i	..	n a i	..	ff	np i	ff	2-30—4-15 P.M.
n i	ffr	..	np i	..	n a i	..	n i	..	np a i	np i	n i	11-30 A.M.—1-21 P.M.
f	n i	..	ffi	..	np a i	..	n i	..	ff r	Dead	np i	1-36—3 P.M.
Dead	ff	..	n i	..	fr	..	f	..	ffr	..	n i	1-39—3-24 P.M.
	Dead	..	n i	..	Dead	..	Dead	...	fa	..	ff a i	2-58—4 P.M.
..	..	..	fi	..	..	..	..	..	ff a	..	ff a	2-52—3-55 P.M.

skin without drawing blood, but later on took a feed.

Table showing biting propen

Rabbit or Bull No.	Date	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18
Rabbit 2425.	28	ff i						n i	n i		ffr	n i	ff				f		
	29	ff a						ff	ffr		f	n i	ffr a				n i		
	30	n i						f a	ff		fa		ff				np i		
	1	n i						n i	n i		np a i		np a i				n i		
Rabbit 2448.	2	n i						n i	ff		ff		ff				n i		
	3	ff r						ff r	ff i		f		ff a				n i		
	4	ff i						ffi	ff i		np i		ff a						
	5	n i						ffi	f a		fp i		f a						
	6	ff						n i	ff i		ffr		np a i						
Rabbit 2527.	7	n i						ff	n i		np a i		f a						
	8	n i						f a i	ff		n i		n						
Bull 2631 (Chapper 54).	9							Not tried	Not tried		Not tried		Not tried	Dead	Dead	Dead		Dead	Dead
	10		Dead	Dead	Killed	Dead	Dead		n i	Dead	n i	Dead	n i						
	11								n i				ff						
	12												ffr				Dead		
	13												n a i						
	14												ffr						
	15	Dead											Not tried						
	16							Dead	Dead		Dead		n i						
	17												n i						
	18												np i						
	19																		
	20																		
	21												Dead						
	22																		

N.B. When "p" occurs with "f" or "ff," it indicates that for a while the mosquito punctured the

sities of A. (S.) albopicta—contd.

No. 19	No. 20	No. 21	No. 22	No. 23	No. 24	No. 25	No. 26	No. 27	No. 28	No. 29	No. 30	Time of experiment and condition of weather
..	..	..	n i	..	..	..	..	..	ff	..	ffr	2-10—2-53 P.M.
..	..	..	Dead	..	..	..	..	..	ff	..	fa	1-55—2-25 P.M
									n i		ff	12-45—1-40 P.M.
									f		n i	12-45 P.M. – not noted.
									ff		n i	2-25—3 P.M. (Cloudy and chilly.)
									ffr		ff	12-54—1-20 P.M. (Uncertain weather.)
									np a i		n i	2—2-30 P.M. (Very chilly and sunny).
									n i		n i	1-8—1-40 P.M. (Uncertain weather.)
									ffr		ffr	12-20—12-54 P.M. (Uncertain weather.)
									ffr		n i	2-35—3-9 P.M. (Not chilly; uncertain weather.)
									ffi		ffr	1—1-34 P.M. (Chilly and sunny.)
									Not tried		Not tried	
									n i		np i	10-35—11-15 A.M.
									ffr		ff i	10-36—11-20 A.M. (Uncertain weather.)
									np a i		ff r i	10-45—11-22 A.M. (Sunny and chilly.)
									ffa		n i	10-15—10-45 A.M. (Sunny and chilly.)
									n i		np a i	10—10-42 A.M. (Sunny and chilly.)
									Not tried		Not tried	
									n i		n i	
									Dead		n i	9-40—10 A.M. (Uncertain weather.)
											ff	10-10—10-50 A.M. (Sunny and chilly.)
											n i	9-30—9-45 A.M. (Very chilly and sunny.)
											n i	9-50—10-45 A.M. (Chilly and sunny.)
											n i Dead	9-25 A.M (Chilly and sunny.)

skin without drawing blood, but later on took a feed.

REMARKS.

7-IX. No. 15 moribund at 11-30 A.M. and found dead at noon.
No. 16 bit when repeated attempts had been made to make it do so; No. 18 without one leg; No. 26 covered over with brown excrement. No. 1 undersized.

8-IX. No. 18 unable to poise and bit after repeated attempts.

9-IX. No. 13 took a long time to feed; No. 14 punctured several times in attempting to feed; No. 18 moves with a jerky motion; No. 9 without one leg; No. 28 fed in several instalments.

10-IX. No. 12 fed in instalments and showed marked tendency to fly towards muslin, although the latter was away from light; No. 18 fed very slightly; No. 9 sluggish.

11-IX. No. 9 fed slightly after several attempts; No. 18 moved proboscis along margin of tube (although itself seated on animal) as if in search of something; No. 1 sluggish; No. 22 fed very slowly; No. 5 undersized.

12-IX. No. 13 had abdomen very thin and took a long time to feed; No. 11 fed when tried a third time; No. 14 fed when tried a third time.

13-IX. No. 9 slightly injured; No. 14 took a long time to feed; No. 18 very weak; No. 25 kept oscillating its body while feeding.

14-IX. No. 7 without one leg; No. 20 moved proboscis like No. 18 on 11-IX; No. 9 weak; No. 13 fed slightly; No. 21 took a long time to feed.

15-IX. No. 8 fed slightly; No. 1 thin; No. 9 thin; No. 18 fed, although unable to balance itself.

16-IX. No. 11 fed in two efforts; No. 13 probably slightly fed; No. 18 behaved as it did on 11-IX; No. 23 moribund(?); No. 8 made repeated efforts to bite.

17-IX. No. 13 moribund; No. 17 fed slightly.

18-IX. No. 17 sluggish, but bit all on a sudden; No. 24 would probably have fed at once, but rabbit difficult to immobilize; No. 25 moribund (3-20 P.M.); No. 24 imbibed only a small quantity of blood during first bite, but was fully gorged when bit a second time; No. 25 dead at 4-30 P.M.

19-IX. No. 10 behaved like No. 18 on 11-IX; No. 13 very sluggish and moved with difficulty, but energetically punctured skin, and collapsed all on a sudden, but revived again; No. 14 fed in several efforts; No. 28 fed in three efforts; No. 9 took a long time to feed.

20-IX. No. 20 behaved as No. 18 did on 11-IX; whether No. 24 had fed could not be definitely ascertained owing to insufficient light (cloudy day); No. 30 bit as the result of considerable teasing; No. 19 fed when repeated attempts had been made to make it do so.

21-IX. No. 9 sluggish; No. 19 suddenly took to feeding as the result of considerable teasing; No. 26 looked as if stupefied while biting.

22-IX. No. 12, which fed in two instalments, took a fairly full feed during first bite and fed only slightly during second bite.

23-IX. No. 9 took a long time to feed ; No. 14 looked moribund, but bit (it behaved as No. 18 did on 11-IX) ; during first trial No. 17 looked as if it would feed, but never actually punctured skin ; No. 19 probably would have fed, but rabbit difficult to immobilize ; No. 12 fed readily when tried a second time ; No. 28 stabbed skin every time it was tried ; No. 29 looked moribund when tried a second time.

25-IX. Nos. 16 and 24 fed slightly.

26-IX. No. 1 fed slightly ; No. 20 moribund (1-30 P.M.) ; No. 7 fed in instalments ; No. 30 fed very readily when tried a second time; No. 2 dead at 4—15 P.M. Examined contents of alimentary tract of No. 2 and noticed fresh blood in the anterior portion of stomach.

28-IX. No. 16 took a long time to feed ; No. 22 moribund and made efforts to puncture skin but failed ; No. 28 fed in repeated efforts and excreted frequently ; No. 22 dead at 2—53 P.M.

29-IX. No. 28 fed on repeated pressure.

30-IX. No. 28 fed very slightly (?). Rabbit moribund at 1-48 P.M.

1-X. Rabbit dead at 2 P.M.

3-X. Nos. 1 and 10 took a long time to feed ; No. 30 took a rather long time to feed ; No. 28 bit as the result of much pressure ; No. 16 moribund.

4-X. Several of the mosquitos (*e.g.*, Nos. 1 and 8), although they stubbornly refused to bite, bit as soon as the window was opened to let in chilly wind.

5-X. Nos. 7 and 10 bit when repeated efforts had been made to make them do so.

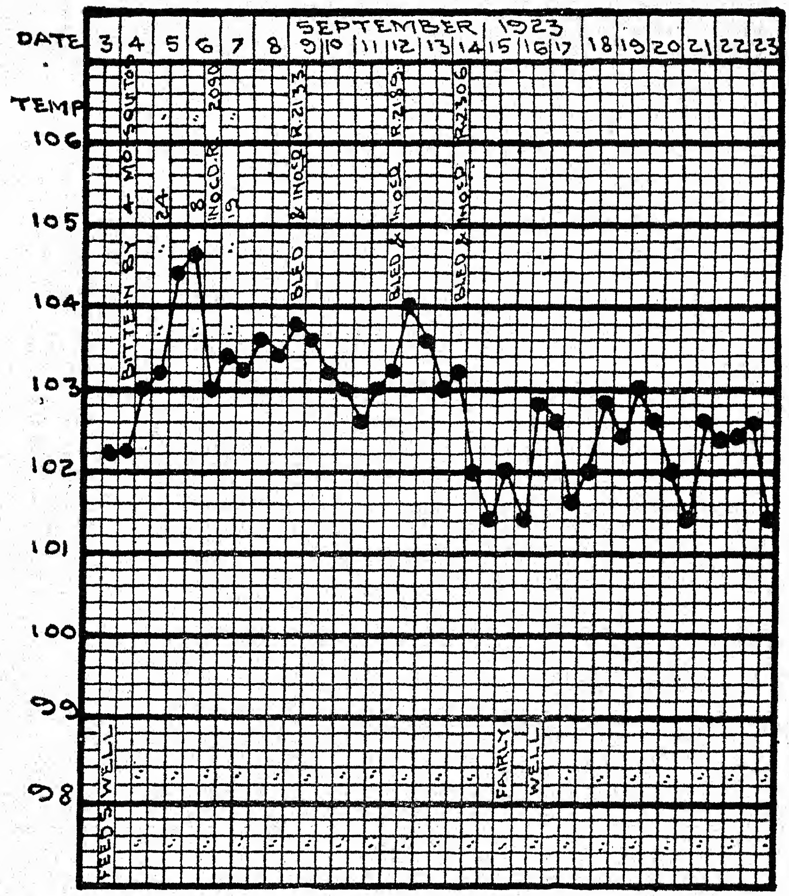
6-X. No. 12 punctured very readily when tried a second time.

7-X. No. 28 took a long time to feed.

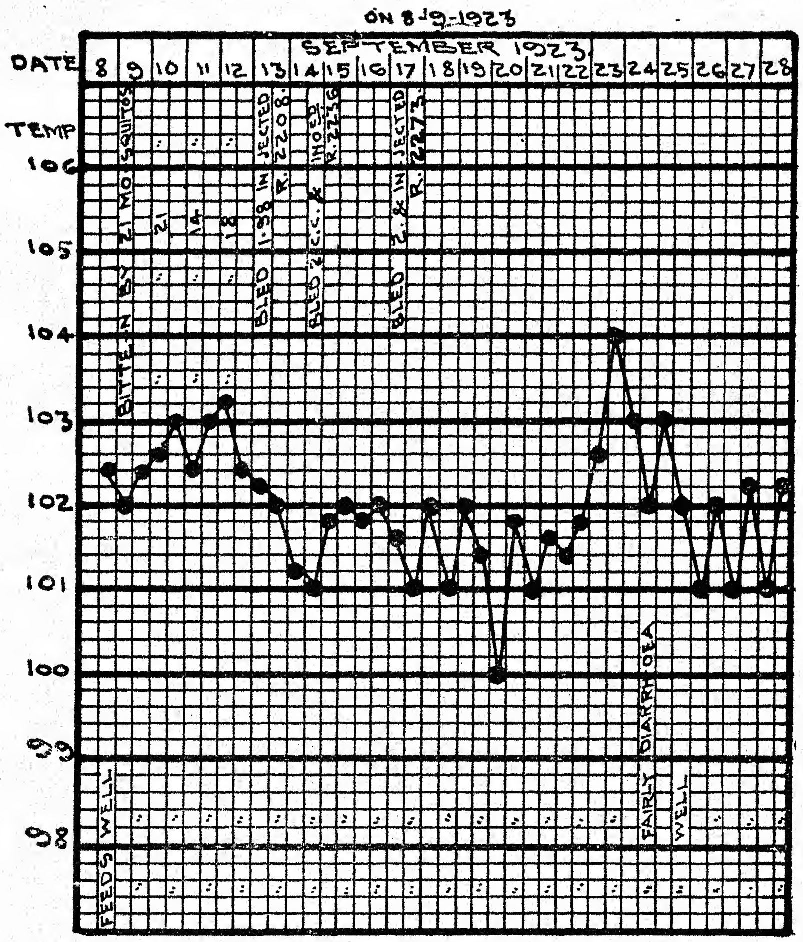
8-X. No. 7 fed slightly.

As will be seen from the foregoing table, there were eight rabbits bitten by infected mosquitos, of which two died during the progress of the experiments. The blood from the remaining six was "passaged" through a series of rabbits with a view to intensifying the thermal reactions manifested by the originally infected (bitten) rabbits. The blood was thus "passaged" through sixty-five rabbits divided into six series corresponding to the six rabbits bitten by infected mosquitos, but the interpretation of the results obtained by "passaging" was rendered difficult by the supervention of pasteurellosis amongst the experimental animals. During this period, the infectivity of particular strains of the rabbit virus was also tested upon cattle (nine bulls were thus used), but the results of these tests were negative.

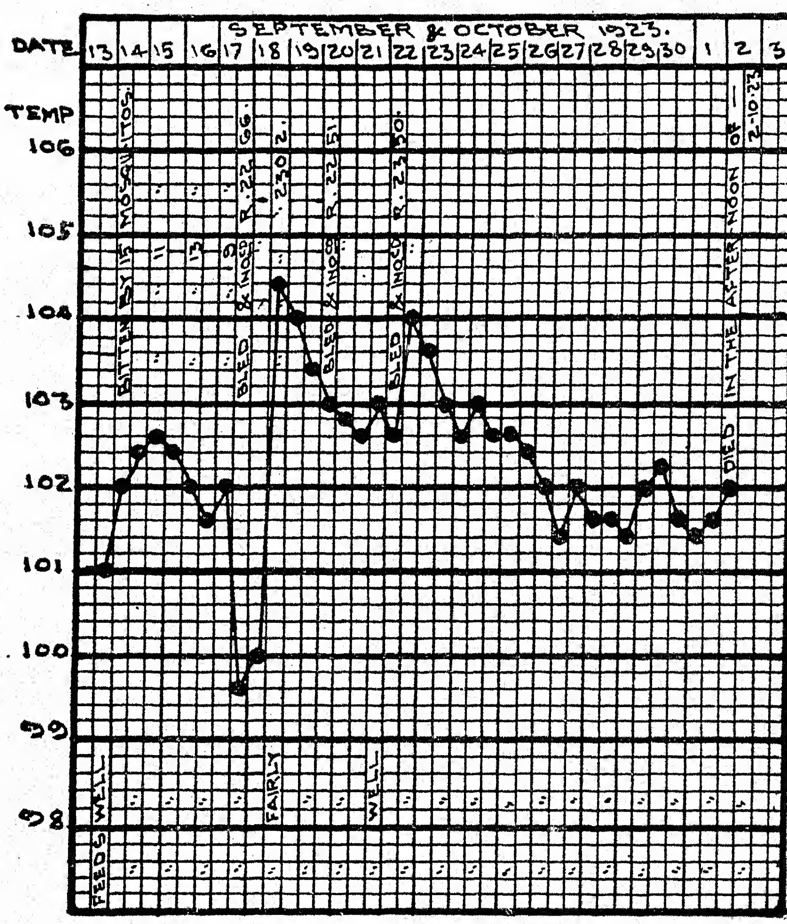
The clinical observations made on the six rabbits bitten by infected mosquitos are shown in the attached charts.



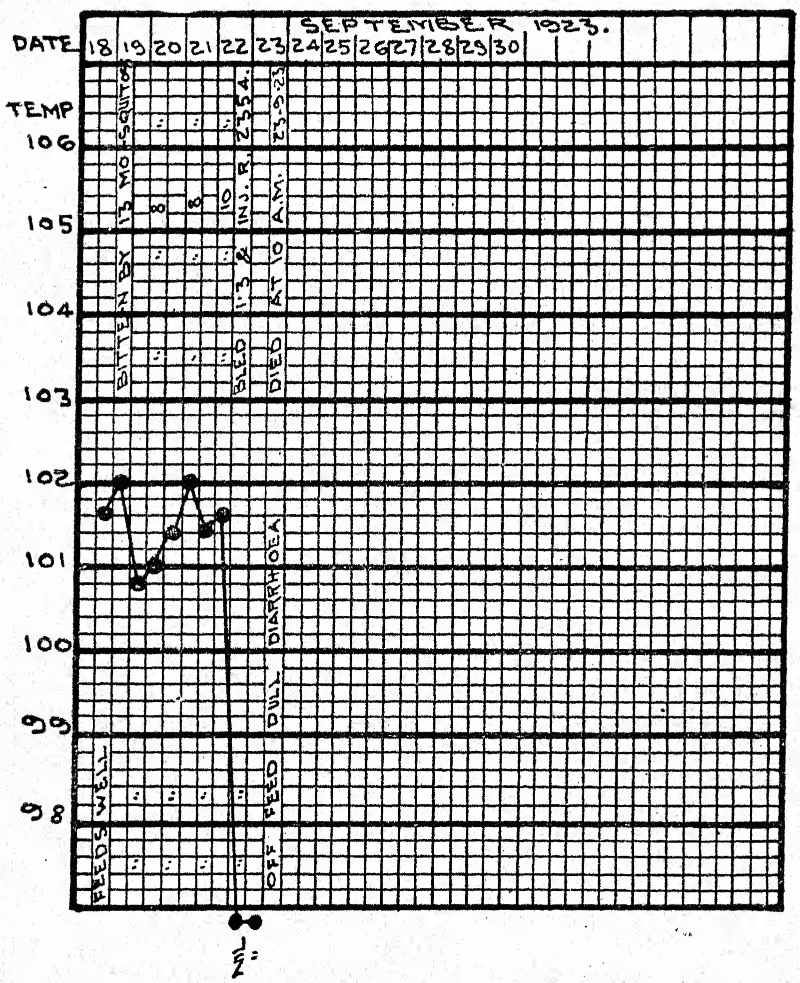
Rabbit 2042.
Bitten by 15 mosquitos (fed from R. 1993, 2 days' strain)
on 3—IX—1923.



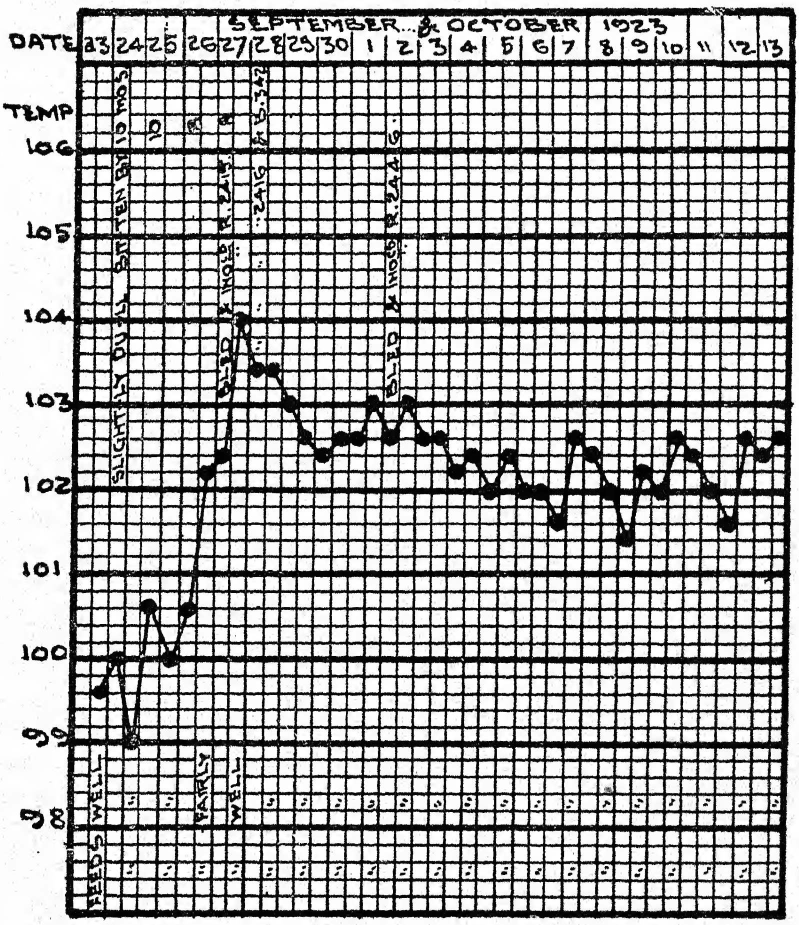
Rabbit 2043
Bitten by 15 mosquitos (fed from R. 1995, 2 days' strain)
on 8—IX—1923.



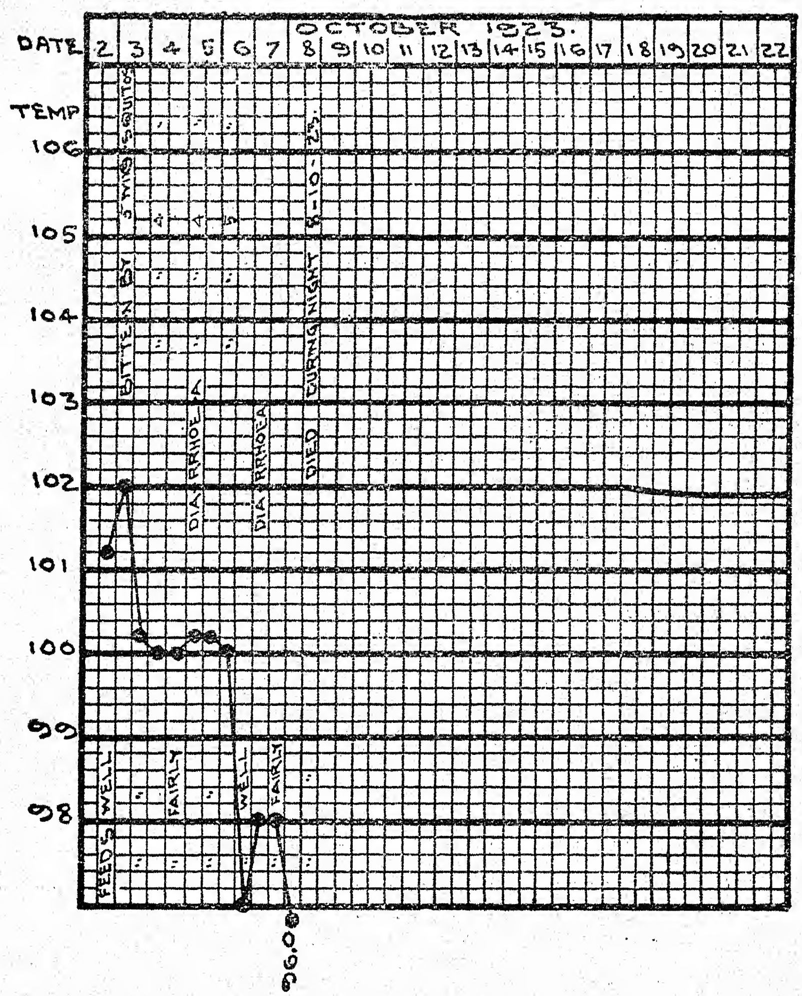
Rabbit 22101.
(Bitten by 15 mosquitos on 13—IX—1923.)



Rabbit 2301.
(Bitten by 9 mosquitos on 18—IX—1923.)



Rabbit 2312.
(Bitten by 7 mosquitos on 23—X—1923.)



Rabbit 2448.
(Bitten by 4 mosquitos on 2—X—1923.)

The inoculation of the bodies of infected mosquitos into bulls. Result: Negative.

1. Inserted Mosquito 50 (uncrushed) into Bull 2653, Chupper 46 ; 3-VII, 4-45 P.M.
2. Inserted Mosquito 51 (uncrushed) into Bull 2654, Chupper 44 ; 3-VIII, 4-15 P.M.
3. Inserted Mosquito 52 (uncrushed) into Bull 2661, Chupper 22 ; 3-VIII, 4-22 P.M.
4. Crushed Mosquitos 35, 42, 44 and 49 and inserted into Bull 2723, Chupper 38 ; 13-VIII, 5-45 P.M.
5. Crushed Mosquitos 53, 54 and 55 and inserted into Bull 2720, Chupper 34 ; 13-VIII, 6 P.M.

The dissection of infected mosquitos.

1. Fed one mosquito on Control 2350 on 29-VII, 3 P.M. Dissected and examined dark-ground on 29-VII, 5 P.M.

Corpuscles nearly intact, well-rounded, showing up brightly ; a small proportion had lost refractivity of edges. Around several corpuscles, which were apparently beginning to show distortion, there were festoons of short processes with blunted knob-like ends. The majority, however, appeared to be free, but in the relatively stationary parts of the preparation the number of festooned corpuscles appeared to be greater. In places there was evidence of the formation of fibrin in the form of scarcely visible, stationary, bristle-like threads. The plasma contained an enormous number of colloid particles, showing active Brownian movements ; more rarely, at the rate of 1 to 2 per field, there were larger active bright dots, which, on careful resolution, appeared to consist of 2 or 3 or more granules, joined together and performing active vibrionic movements. Sometimes long, thick, wriggling shreds could be seen, evidently pseudo-spirochætes, also bright coccoid particles. No forms could be seen definitely approaching *Leptospira*, although some of the forms, stated to be pseudo-spirochætes as a precautionary measure, displayed characteristics not far removed from those of *Leptospira*.

Examined salivary glands dark-ground. No motile structures but glandular cells and a number of stationary coccoid particles were seen.

2. *Mosquito 45*. Fed on Control 2410 on 28-VII, 12-30 P.M. Dissected and examined dark-ground on 29-VII, 5 P.M.

Aspirated some of the contents with salt solution. The resultant mixture was light bright-red in colour and appeared to contain minute coarse particles. Examined dark-ground, the red corpuscles were still seen to be intact, and also what appeared to be blood-platelets and some granular masses, probably leucocytes. Plasma contained an immense number of minute colloid particles, the great majority of which was stationary, but many executed Brownian movements. No definitely spirillar form was noticed. Occasionally faint corpuscles, that had lost refractivity were seen ; rarely some larger particles which had granular vibrionic form were

seen. In places the faint corpuscles appeared to be in a process of disintegration. Very rare pseudo-spirochætal forms were seen with prominent ends.

3. *Mosquito 48*. Fed on Control 2420 on 30-VII, 11-30 A.M. Dissected and examined dark-ground on 30-VII, 6-30 P.M.

Contained a few remnants of corpuscles, many still rounded, but not showing bright refractive edges. Very numerous colloid particles in the plasma, showing active Brownian movements, were seen; a few showed granular vibrionic structure. Some extremely fine filaments were seen, probably pseudo-spirochætes, but occasionally one rather resembling a *Leptospira* was seen, with minute special structure. On close search many small structures of this kind were seen. Forms rather resembling Leishman's "granule clumps" could occasionally be seen represented by several bright granules within a delicate vesicular envelope. In fact, structures of this kind were very numerous when the preparation got to rest. Definite pseudo-spirochætes, actively lashing and attached to remnants of corpuscles or platelets were also seen. Some very long forms of this kind were also noticed.[1]

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[1] The dark-ground examination of these three slides was kindly made by the Director of the Muktesar Laboratory.

APPENDIX I.

The Life-history of A. (S.) albopicta *in High Altitudes.*

1. *Mosquitos bred from Pusa tree-hole materials.*

Pusa tree-hole materials I.

(1)

11-V, 4-15 P.M. Put in water.
12-V, noon. Many found hatched.
20-V, 10 A.M. None pupated yet.
21-V, 10 A.M. Several pupated.
25-V, 10 A.M. No mosquito emerged yet.
26-V, 10 A.M. About 10 males emerged.
27-V. 15 males emerged.
28-V, 4 males emerged.
30-V. Only females emerging.

(2)

18-V. Put in water.
19-V. Found hatched.
29-V. Pupated.
31-V. No mosquito emerged yet.
1-VI. A large number of males emerged.
2-VI. A large number of males and 1 female only emerged.

(3)

31-V, 11-30 A.M. Put in water.
1-VI. Found hatched.
6-VI. Pupated.
9-VI. A large number of females and males (a larger proportion of the latter) emerged.

(4)

10-VI, 3-30 P.M. Put in water.
11-VI, 11-30 A.M. Found hatched.
18-VI. Both males and females emerged.

(5)

27-VI, 11-30 A.M. Put in water.
28-VI, morning. Found hatched.
4-VII. 1 only pupated.
5-VII. Many pupated.
8-VII. 4 or 5 males emerged.
9-VII. Several males emerged.
10-VII. 1 female and several males emerged.

Pusa tree-hole materials I.

11-VII, 2 P.M. 3 females emerged.
12-VII. 4 females emerged.
13-VII. 2 females emerged. Only 1 pupa left
15-VII. No further emergence yet.
16-VII. 1 male *A. (S.) thomsoni* emerged.

(6)

12-VII, 3-45 P.M. Put in water.
13-VII, 11 A.M. Found hatched.
21-VII, 2-30 P.M. A few pupated.
24-VII. Mostly pupated.
25-VII, 2 P.M. All not yet pupated. 1 male emerged.
26-VII, noon. About 10 males and 1 female emerged.
27-VII, 3 P.M. About 8 females and 2 males emerged.
28-VII, 11 A.M. 1 female emerged.
29-VII. None emerged.
30-VII to 1-VIII. Ditto.
2-VIII, 8 P.M. 1 female and 2 male *thomsoni* emerged.
3-VIII, noon. 2 male *thomsoni* emerged.

(7)

16-VII, 2-45 P.M. Put one handful of materials in water.
17-VII, noon. Found hatched.
26-VII, noon. A few pupated.
27-VII, 3 P.M. Many pupated.
1-VIII. 6 females and 2 males emerged
2-VIII, 4-20 P.M. 3 females and 1 male emerged.

(8)

2-VIII, 3 P.M. Put a large quantity of materials in water.
3-VIII, 12-50 P.M. Many found hatched.
11-VIII. Many young larvæ dead. Water turbid and stinking.

14-VIII 1 found pupated.
19-VIII, 10-30 A.M. 1 female emerged.
23-VIII, 11 A.M. 1 male emerged.
24-VIII. 1 male emerged.
noon. 1 female *thomsoni* emerged.
27-VIII, 11-20 A.M. 1 female *thomsoni* and 1 dwarf male *albopicta* emerged.

N.B. The tree-hole materials used in this experiment contained a large quantity of wild dry fruits and pieces of wood, and this probably accounted for the turbidity and foul smell of the water. Later on, the foul water was thrown away and fresh clean water was used after washing the materials themselves as thoroughly as possible, but this was of no avail, as most of the larvæ were already dead.

(9)

15-VIII, 3 P.M. Put in water.
16-VIII, noon. Hatched.
17-VIII, 4-15 P.M. Put in incubator (28°C.).
21-VIII, noon. 4 pupated.
22-VIII, noon. Mostly pupated.
23-VIII, 1 P.M. 3 males and 1 female emerged.
23-VIII, 4 P.M. 1 male emerged.
24-VIII, 5 P.M. 2 females emerged.
25-VIII, 1 P.M. No emergence. 3 pupæ and 2 larvæ left.
26-VIII, 1 P.M. No emergence.
27-VIII, 4 P.M. 1 female *albopicta* and 1 female *thomsoni* emerged.
28-VIII, 12-35 P.M. 1 female *albopicta* emerged.
3 P.M. 1 pupa left.
29-VIII, 2-30 P.M. No emergence.
30-VIII, 2 P.M. 1 female *thomsoni* emerged.
31-VIII, 11 A.M. The newly-emerged *thomsoni* found dead.

(10)

21-IX, 3 P.M. Put in water.
3-45 P.M. Put in incubator (28°C.).
22-IX, 2-5 P.M. Hatched.
26-IX, 1-10 P.M. 1 pupated.
28-IX, 3 P.M. All pupated.
29-IX, 4-30 P.M. 2 females emerged.
30-IX, 1-56 P.M. No emergence.
1-X, 2 P.M. Only 1 male *thomsoni* emerged. No pupa left.
2-X, 3-20 P.M. The male *thomsoni* still alive.
4-X, 3 P.M. The male *thomsoni* found dead.

Pusa tree-hole materials II.

(1)

11-V, 4-20 P.M. Put in water.
12-V, noon. Hatched.
21-V, 10 A.M. None pupated yet.
22-V, 10 A.M. Ditto.
23-V, 10 A.M. Pupated.
26-V. No adult emerged yet.
27-V, 1 male emerged.
28-V. 2 males emerged.

(2)

18-V. Put in water.
19-V. Hatched.
27-V. Pupated. (Dates of emergence of adults not noted.)

(3)

13-VI, 3-30 P.M. Put in water.
14-VI, morning. Hatched.
20-VI. Pupated.
(Dates of emergence of adults not noted.)

Pusa tree-hole materials II.

(4)

9-VII, 4 P.M. Put a large quantity of materials in water.
10-VII, 2 P.M. None found hatched yet.
11-VII, 1 P.M. Hatched.
19-VII, 4 P.M. Mostly pupated.
21-VII, 2-40 P.M. Except one, all the larvæ pupated.
23-VII, 2 P.M. 1 female emerged.
24-VII, 11-45 A.M. 3 females emerged.
25-VII, 2-30 P.M. 1 female emerged.
2-VIII. 1 female *thomsoni* emerged.

(5)

2-VIII, 4 P.M. Put a large quantity of material in water.
3-VIII, 1 P.M. Hatched.
15-VIII, noon. 4 pupated.
16-VIII. noon. 3 more pupated.
18-VIII, 1 P.M. 1 male emerged.

19-VIII, 1 P.M. 2 males emerged.

20-VIII, noon. 2 males and 1 female emerged.

21-VIII, noon. 1 male and 1 female emerged.

22-VIII, noon. 1 female emerged. Only a few larvæ left.

23-VIII, 11 A.M. 2 pupæ and 1 larva in vessel.

25-VIII, noon. Ditto.

28-VIII, 3 P.M. Ditto.

1-IX, 4 P.M. Only one larva left.

5-IX, 3-15 P.M. Ditto.

12-IX, 12-12 P.M. The larva found pupated.

18-IX, 2 P.M. 1 female *thomsoni* emerged.

(6)

21-IX, 3 P.M. Put a fairly large quantity of materials in water.

22-IX, 2 P.M. None found hatched.

24-IX, 4 P.M. Ditto.

29-IX, 1-6 P.M. 2 slightly grown-up larvæ seen in vessel.

4-X, 3-26 P.M. Larvæ evidently not full-grown.

9-X, 2-45 P.M. Only 1 (evidently almost full-grown) larva seen in vessel. (Water very cold.)

11-X, 1-15 P.M. Larva not pupated yet.

13-X, 1-15 P.M. Ditto.

17-X, 12-15 P.M. Ditto.

21-X, 11-30 A.M. Larva in same condition. (Temperature of water 12·5°C.)

26-X, 4 P.M. Larva dead. (Temperature of water 17°C.)

2. *Mosquitos reared from eggs deposited in captivity.*

N.B. Except where otherwise mentioned, there was always a supply of sugar solution or raisins for the enclosed mosquitos to feed upon, and of moist filter paper to oviposit upon.

(1)

19-VI, 3 P.M. Enclosed several males and 3 females in bottle A—all bred under laboratory conditions but early history not noted.

22-VI, 3-30 P.M. Offered arm. 2 engorged and transferred to bottle C; the other did not bite.

27-VI, 11 A.M. 1 female in bottle C dead. Offered arm to the remaining mosquito in bottle A; bit.

28-VI, 3 P.M. The remaining mosquito in bottle C dead. 4-30 P.M. Transferred mosquito from bottle A to cloth cage into which a male was also introduced. Offered arm; bit.

29-VI, 11-30 A.M. Offered arm; did not bite. 4-15 P.M. Offered arm again; did not bite.

30-VI, 3 P.M. Offered arm; did not bite. Found pairing for a minute. 4 P.M. Found pairing again. Offered arm; bit.

2-VII, 4 P.M. Offered arm; bit. Introduced a newly-emerged male. Observed pairing.

3-VII, noon. Offered arm; did not bite. Added water to sugar solution.

4-VII, 3 P.M. Offered arm; bit. Both the males alive.

5-VII, 3-30 P.M. Offered arm; did not bite. Introduced fresh water and fresh sugar solution.

6-VII, 4 P.M. Offered arm ; did not bite. Males alive.

7-VII, 12-30 P.M. Offered arm ; did not bite. 1 male dead.

8 VII. Offered arm ; did not bite. Enclosed mosquito in tube and tried again on arm ; did not bite. Surviving male alive. Placed back mosquito into cloth cage.

9-VII, 12-30 P.M. Offered arm ; did not bite. Introduced more males.

10-VII, 2-20 P.M. Mosquito distended with sugar solution. Offered arm ; did not bite. Introduced 5 males.

11-VII, 3 P.M. Offered arm ; did not bite. Female sluggish. Males happy.

3-VII, 4-30 P.M. Female sluggish. Males alive. Offered arm ; did not bite. Introduced fresh sugar solution.

15-VII, 1 P.M. Offered arm ; did not bite.

16-VII, 4 P.M. 12 eggs found deposited (Batch 1). Female seated close to moist filter paper. Introduced fresh sugar solution. Offered arm ; did not bite. Female sluggish. Males alive.

17-VII, 12-15 P.M. Female distended and found sucking sugar solution.

18-VII, 3-30 P.M. Female slightly stuck up in the sugar solution and much distended. It lost one leg while being disengaged by means of a pointed rod. Introduced 6 males bred from Pusa tree-hole materials II.

19-VII, 4 P.M. No more eggs deposited. Mosquito found seated on wall of cage.

20-VII, 3 P.M. Offered arm ; did not bite.

21-VII, 3-30 P.M. Removed female to bottle. Offered arm ; did not bite. Mosquito distinctly gravid.

22-VII, 2-30 P.M. About 20 more eggs laid (Batch 2). Female moribund.

23-VII, 3-20 P.M. Some eggs of batch 1 found hatched.

24-VII, 11-50 A.M. Mosquito still alive. 3 P.M. Transferred larvæ of batch 1 to a mixture of Pusa tree-hole materials II and water, prepared on 9-VII.

25-VII, 2 P.M. Female still alive and seated on moist filter paper. Larvæ of batch 1 growing.

27-VII, 3-30 P.M. Female found dead. Eggs of batch 2 not yet hatched.

30-VII, 10 A.M. One or two eggs of batch 2 found hatched.

31-VII, 4 P.M. No more eggs of batch 2 appear to have hatched. Transferred both eggs and larvæ to a mixture of Pusa tree-hole materials II and water, prepared on 9-VII.

1-VIII, 2 P.M. Larvæ of batch 1 growing steadily. Many eggs of batch 2 hatched but larvæ of unequal size.

2-VIII, 3-30 P.M. All growing steadily.

4-VIII 2-20 P.M. All the larvæ of batch 1 found pupated (7 pupæ in all).

9-VIII 1-45 P.M 3 males emerged from pupæ of batch 1.

10-VIII, 2 P.M. 2 females and 1 male emerged from pupæ of batch 1. Kept these in bottle with raisins.

11-VIII, 4 P.M. Larvæ of batch 2 distinctly uncomfortable. Noticed a fungus-like deposit on water. Larvæ of unequal size. Removed the larvæ, one by one, to a cleaner mixture, prepared on 2-VIII, of Pusa tree hole materials II and water.

12-VIII, 2-30 P.M. Added 2 grains of rice to the water containing the larvæ of batch 2.

14-VIII noon. Transferred larvæ of batch 2 to clean tap-water in which a few grains of rice had been placed. 2 larvæ of batch 2 pupated. Tried the two femles of batch 1 (emerged on 10-VIII) on Control 2461 ; both bit (Mosquitos 56 and 57), one being seen pairing prior to feeding.

15-VIII, 11 A.M. One of the two pupæ of batch 2 dead. Added 3 dry specimens of *Musca* sp. to the water containing larvæ of Batch 2.

16-VIII, noon. 1 male emerged from batch 2.

N. B. The following observations relate to batch 2.

17-VIII noon. 1 pupated, but pupa very small in size.

20-VIII, noon. 1 more pupated.

21-VIII, 11 A.M. 2 more pupated. 1 female emerged.

22-VIII, 3 P.M. No emergence. Altogether 5 pupæ now.

25-VIII, 11-30 A.M. 1 female emerged. Except 2 larvæ, all pupated.

26-VIII, 11-45 A.M. 1 female emerged.

27-VIII, 11-20 A.M. Ditto.

2-30 A.M. Ditto.

28-VIII, 2-30 P.M. No further emergence.

29-VIII, 1 P.M. 1 male and 1 female emerged.

30-VIII, 1 P.M. No further emergence.

1-IX, 3-30 P.M. 2 females emerged.

(2)

20-VII, 3 P.M. Enclosed 4 three-day old males and 2 females. (One female emerged on 17-VII, the other on 18-VII, both from Pusa tree-hole materials II.) Offered arm ; both females bit.

21-VII, 3 P.M One male dead. Offered arm. 1 female bit readily; the other did not bite.

23-VII, 4 P.M. 1 male dead. Offered arm ; none bit. 1 female moribund (evidently the one which had refused to bite yesterday).

24-VII, 4 P.M. The moribund female still alive; the other very sluggish. Both seated on moist filter paper and could not be induced to move.

25-VII, 2 P.M. Both females alive and still seated on moist filter paper. 1 male only alive.

27-VII, 3-30 P.M. I female dead ; the other laid 60 eggs and was moribund (having lost one leg).

28-VII, 11-30 A.M. The female alive. No more eggs laid.

29-VII, 10 A.M. The female dead. No more eggs laid.

31-VII. None of the eggs hatched.

1-VIII. Ditto.

2-VIII, 3 P.M. Several eggs hatched. Placed the newly hatched larvæ in a decoction of Pusa tree-hole materials II.

12-VIII, 1 P.M. Larvæ not growing satisfactorily.

13-VIII, 2 P.M. Added $2\frac{1}{2}$ grains of rice to the water.

14-VIII. All the larvæ transferred to bottle (they had been so long in the lid of a bottle).

15-VIII, 11-30 A.M. Added 3 dry specimens of *Musca* sp. and many of the larvæ attacked them immediately although the specimens were floating.

17-VIII, 3-15 P.M. Larvæ growing steadily. Dry flies still floating. Smashed the flies by pressing them hard with forceps, when many of the pieces sank immediately (this was done in view of the fact that *Stegomyia* larvæ are bottom-feeders). A larva seen carrying about a large piece in its mouth, being afterwards joined by many more larvæ.

18-VIII, 1 P.M. Added 4 more dry flies.

21-VIII, noon. None pupated.

4 P.M. A few pupated ; pupæ medium-sized.

23-VIII, 11 A.M. Altogether a dozen larvæ pupated.

25-VIII, 11-30 A.M. The majority of the larvæ pupated.

26-VIII, 11-45 A.M. 1 male emerged.

27-VIII, noon. About 10 males and 1 female emerged. The remaining pupæ and larvæ transferred to a large bottle, with plenty of water.

28-VIII, 1 P.M. About 15 males and 8 females emerged. None of the mosquitos could be induced to leave surface of water, apparently owing to low temperature.

4 P.M. All the larvæ pupated except three or four.

29-VIII, noon. 1 more female emerged. Failed to induce emerged mosquitos to leave surface of water ; only 2 females came up as the result of continuously shaking the bottle. The mosquitos refused to leave surface of water even when disturbed with a rod. Pupæ and larvæ also very sluggish. Temperature of room, 18°C.

2-4 P.M. 2 females came up as a result of bottle being kept in incubator for 15 minutes ; the rest had to be removed by means of a rod. Placed bottle in incubator.

30-VIII, 1-30 P.M. 13 females and 4 males emerged. Mosquitos quite active and very readily came up. All larvæ pupated by now.

31-VIII, 12-30 P.M. 6 females emerged. Emerged mosquitos quite active and very readily came up.

1-IX, 2-15 P.M. 3 females emerged and quite active.

N. B. All the mosquitos emerged in this series were used for feeding on rabbits.

(3)

26-VII. Introduced 1 newly-emerged female and 7 newly-emerged males into cloth cage.

27-VII. Added 2 more females and 3 more males.

28-VII, 3 P.M. Offered arm ; none bit, Transferred mosquitos to bottle.

30-VII, 10 A.M. 2 males dead.

noon. Removed raisins. Changed filter paper.

31-VII, 2-40 P.M. Offered arm ; all the 3 females bit readily. 1 more male dead. Put in a raisin.

2-VIII, 4-30 P.M. 1 male dead.

4-VIII, 3 P.M. Offered arm ; none bit. 1 male dead. Removed raisin as it had been covered over with fungus. Changed filter paper.

6-VIII, 3 P.M. Offered arm. 1 bit ; the rest did not bite, although they were several times induced to settle on the arm. 1 male dead and 1 moribund. Put in a raisin.

8-VIII, 4-20 P.M. Offered arm ; did not bite. Changed filter paper.

9-VIII, 3 P.M. Offered arm ; 1 bit. Put in a fresh raisin.

10-VIII, 2-30 P.M. Offered arm ; none bit. All the mosquitos distended with juice of raisin. 3 males alive. Removed raisin.

11-VIII, 3 P.M. Offered arm ; only 2 bit. 2 males alive. Put in a raisin.

12-VIII, 12-30 P.M. 3 eggs deposited on moist filter paper. Only 1 male alive. Removed raisin.

13-VIII, 2 P.M. About 80 eggs deposited on moist filter paper (Batch 1). All females and only 1 male alive.

14-VIII, noon. No more eggs deposited. 1 female (evidently the one that had oviposited) moribund ; its abdomen was open for more eggs, but none could be found.

15-VIII, 3-30 P.M. About 50 light-black and a few white eggs deposited on moist filter paper (Batch 2). 1 female (apparently the one that had oviposited) moribund. Offered arm to the remaining mosquitos ; bit. Removed the two batches of eggs, along with the filter paper on which they had been deposited, and supplied fresh moist filter paper to the remaining mosquito.

16-VIII, noon. The colour of the light-black eggs deepened to some extent.

17-VIII, 11-45 A.M. All the eggs, except the white ones, now turned black. No male alive.

18-VIII, 1 P.M. The eggs that were submerged were removed, one by one, to a moist piece of filter paper and kept exposed to atmosphere. This was done in view of the opinion of some observers, that submerged eggs do not hatch or take a long time to hatch.

19-VIII, 10-45 A.M. 2 eggs hatched.

20-VIII, 4-45 A.M. Many eggs hatched. The young larvæ and the unhatched eggs transferred to bottle, rice grains and dry flies being offered as food. About 80 eggs laid by the surviving mosquito (Batch 3).

N. B. The following observations relate to batches 1 and 2. The observations relating to batch 3 are given separately. Batches 1 and 2 were kept together.

25-VIII, 11-30 A.M. A few young larvæ seen to-day; these probably hatched out of eggs of batch 2.

29-VIII, 11-50 A.M. Larvæ growing steadily.

4-IX, 11-45 A.M. Several pupated.

5-IX. Pupæ and larvæ good-sized (*cf.* pupæ and larvæ of batch 3 in incubator).

7-IX, 4 P.M. 1 male emerged.

8-IX, 5 P.M. 2 males emerged.

9-IX, 2 P.M. 1 female and several males emerged. Adults good-sized.

10-IX, 3-30 P.M. 5 males and 1 female emerged. The newly-emerged adults could not be induced to leave surface of water.

4-30 P.M. bottle placed in incubator (28°C.).

11-IX, 3 P.M. 8 females and 5 males emerged.

12-IX, 5-20 P.M. 3 females emerged (all of good-size). 3 big larvæ and a few small larvæ now left.

13-IX, 2-45 P.M. 3 females emerged.

14-IX, 4 P.M. No further emergence.

15-IX, 4-20 P.M. 2 males emerged.

16-IX, 1-20 P.M. No further emergence.

17-IX, 4-30 P.M. 2 females emerged. 2 pupæ and a small larva left.

18-IX, 4-30 P.M. 1 female emerged.

24-IX, 4-10 P.M. 1 female emerged.

Batch 3. (See against date 20-VIII above.)

20-VIII, 11-45 A.M. About 80 eggs laid.

27-VIII, 11-50 A.M. None hatched yet.

28-VIII, 1 P.M. Many hatched.

2 P.M. The young larvæ and the unhatched eggs removed to a small bottle, 10 dry flies and 4 grains of rice being offered as food.

2-45 P.M. Placed bottle in incubator.

2-IX, 11-30 A.M. 2 larvæ pupated, but pupæ not of good size. Larvæ active, but thin.

noon. Removed larvæ and pupæ to a big bottle with plenty of food.

4-IX, 2-30 P.M. Several larvæ pupated. Larvæ distinctly better.

5-IX, 2-30 P.M 6 males emerged. Some more larvæ pupated, but still many unpupated.

6-IX, 10-30 A.M. Many males emerged.

7-IX 2-30 P.M. 3 females emerged.

8-IX, 2-30 P.M. 2 females emerged. Still a few larvæ unpupated.

9-IX, 1 P.M. 6 females emerged.

10-IX, 2-30 P.M. 7 females and 1 male emerged. All larvæ pupated.

11-IX, 2 P.M. 5 females emerged.

12-IX, 5 P.M. 5 females emerged.

(4)

30-VII. Enclosed 4 newly-emerged males in bottle.

31-VII, 3-15 P.M. Introduced 3 females.

1-VIII, 2-15 P.M. Introduced 2 more males. 1 female accidentally injured. Introduced 1 newly-emerged female. Changed filter paper and raisins.

2-VIII, 4-30 P.M. Removed raisins. Introduced 1 newly emerged male.

4-VIII, 2-30 P.M. Offered arm ; all the 4 females bit.

6-VIII, 3 P.M. 1 male dead.

8-VIII, 4 P.M. Offered arm ; 2 only bit ; 1 persistently refused to feed, whilst the fourth was moribund. Changed filter paper. Only 1 male alive.

9-VIII, 2 P.M. Only 1 male alive. Offered arm ; 1 bit. Introduced 3 newly-emerged males.

10-VIII, 1-30 P.M. Offered arm ; only 1 bit. Put in raisins.

11-VIII, 2-30 P.M Removed raisins.

12-VIII, 12-30 P.M. All the 4 males alive.

13-VIII, 2-30 P.M. 1 female dead. Put in raisins. Changed filter paper.

15-VIII, 2-45 P.M. A male and a female seen pairing seven times during about ten minutes. Offered arm ; 2 bit (the one that had paired did not bite).

16-VIII, 12-45 P.M. Offered arm ; 2 bit (including, apparently, the one that had paired yesterday).

17-VIII, 11-35 A.M. One female moribund, its body lying doubled up in water ; it could not be brought to normal position. Only 2 males alive.

18-VIII, noon. The moribund female of 17-VIII still responded when disturbed. Its abdomen, when squeezed for eggs, expressed only dark blood. 1 more female dead.

19-VIII, 10-30 A.M. The abdomen of mosquito that died on 18-VIII was squeezed for eggs ; only white undeveloped ova seen. Changed filter paper.

22-VIII, 11-30 A.M. The surviving female dead.

(5)

23-VIII, 4 P.M. Enclosed in bottle 1 newly-emerged female, 4 newly emerged males and 2 four-day old males. Bottle kept in incubator at 28°C. The newly-emerged mosquitos were from Pusa tree-hole materials I.

25-VIII, 1-15 P.M. Introduced 2 more females (emerged from Pusa tree-hole materials I). 1 male dead. Rasins covered over with fungus.

3-30 P.M. Changed raisins.

26-VIII, 1-10 P.M. No further mortality. A male and a female seen pairing.

27-VIII, 1 P.M. None dead. Tried on arm; 2 females bit. Removed raisins as they were covered over with fungus. Washed filter paper to remove traces of raisin.

28-VIII, 3 P.M. Offered arm; none bit.

29-VIII, 2 P.M. 1 male dead. Offered arm for a long time; none bit. Mosquitos very sluggish when brought out of incubator for feeding. (Temperature of room, 18°C.)

30-VIII, 2 P.M. 30 eggs deposited on filter paper. No further mortality.

31-VIII, 11 A.M. 15 more eggs deposited. No mortality.

3 P.M. Offered arm for a long time; only 1 female bit.

1-IX, 2-15 P.M. About 60 eggs (altogether) counted to-day. None of the eggs hatched. All males dead, but females all alive.

N.B. All the eggs laid between 30-VIII and 1-IX are included under batch I and further observations relating to these are given separately.

2-IX, 11-30 A.M. No mortality.

1-30 P.M. Offered arm; none bit. Mosquitos sluggish as soon as brought out of incubator.

4-IX, 11 A.M. About 15 more eggs deposited. 1 female moribund (apparently the one that oviposited).

5-IX, 3 P.M. Altogether about 100 eggs counted to-day. 1 female dead.

6-IX, 11 A.M. 1 egg only hatched.

7-IX, 12-15 P.M. Many eggs hatched. All the mosquitos dead. Transferred larvæ to bottle containing water with dry flies and rice grains.

11-IX, 4-30 P.M. Larvæ of uniform size, but undeveloped. Many of the rice grains half-boiled (apparently owing to the heat of the incubator), and this imparted to the water a rancid smell. Separated the larvæ from the water by pouring the materials on a piece of muslin spread over the mouth of a big bottle. Washed the larvæ gently with tap-water and transferred them to clean water containing dry flies only.

15-IX, 1-20 P.M. Larvæ not growing uniformly.

19-IX, 4 P.M. 1 pupated (pupa very small). Larvæ not of uniform size, but quite happy.

20-IX, 3-50 P.M. 1 more pupated.

21-IX, 2 P.M. 2 or 3 more pupated.

22-IX, 2-10 P.M. Many pupated.

23-IX. No adult emerged yet.

24-IX. 4 males emerged.

25-IX, 5 P.M. 4 males and 1 female emerged.

26-IX, 5 P.M. 2 females emerged, both of very small size.

27 IX 4-13 P.M. 2 females and 1 male emerged, all of small size.

28-IX, 3 P.M. No emergence to-day. Still some in the larval stage, but there were a few good-sized pupæ.

29-IX, 4-50 P.M. 1 male and 1 female emerged; male dwarfish, female of medium size.

30-IX, 2 P.M. No emergence to-day. Several well-developed pupæ and many larvæ of unequal size.

1-X, 2 P.M. 2 dwarfish males and 1 female emerged

2-X, 3-5 P.M. 1 male emerged.

3-X, 1-40 P.M. 1 female emerged.

4-X, 2-45 P.M. No emergence.

5-X, 5 P.M. 1 male emerged.

6-X, 1 P.M. 2 males emerged.

7-X, 1-18 P.M. 1 male emerged.

2-7 P.M. As the larvæ were not growing well, a quantity of the water was thrown away and more dry flies and some rice grains were added.

8-X, 3 P.M. 1 male emerged.

9-X, 3 P.M. No emergence.

10-X, 1 P.M. 1 male and 1 female emerged. Rice grains fermenting and water smelling rancid.

11-X, 11-15 A.M. No emergence.

12-X. Ditto.

13-X, 3 P.M. 2 females emerged.

14-X, 11-30 A.M. No emergence.

15-X, 1-30 P.M. 4 females and 1 male emerged.

16-X, 1-30 P.M. 1 mosquito emerged (sex not noted).

17-X, 1-5 P.M. 2 females emerged.

18-X, 1 P.M. No emergence.

Batch I. (See against date 1-IX above.)

2-IX, 11-30 P.M. Some eggs hatched. Transferred the larvæ and the unhatched eggs to a big bottle containing plenty of water with dry flies and rice grains, kept in incubator at 28°C.

6-IX, 10-30 A.M. Added plenty of dry flies.

7-IX, 2 P.M. Larvæ not of uniform size.

10-IX, 3 P.M. 1 pupated.

11-IX, 3-45 P.M. 5 or 6 pupated. Larvæ not of uniform size.

13-IX, 3-40 P.M. 2 males emerged.

14-IX, 4 P.M. 1 male and 1 good-sized female emerged.

15-IX, 4-20 P.M. 2 females and 2 or 3 males emerged. One of the females could not be induced to leave the surface of water.

16-IX, 1-20 P.M. 4 females emerged.

17-IX, 4-30 P.M. 7 females emerged.

18-IX, 5 P.M. Only 1 male emerged. Several larvæ and some pupæ still left.

19-IX, 4-20 P.M. 2 males emerged.
20-IX, 3-45 P.M. 2 males and 1 female emerged.
21-IX, 2 P.M. 1 male emerged.
22-IX, 2-10 P.M. 1 female emerged.
23-IX, 1-30 P.M. 3 males and 1 female emerged.
24-IX, 4-20 P.M. 2 females and 1 male emerged.
25-IX, 5 P.M. 4 males emerged.
26-IX, 4-30 P.M. 3 females and 2 males emerged. Only 3 full-grown larvæ and no pupa left.
1-X, 2 P.M. 1 pupa, 1 apparently full-grown larva and 1 young larva seen.
2-X, 3-5 P.M. 1 female emerged.
3-X, 1-36 P.M. 1 full-grown larva and 1 young larva left.
4-X, 4-45 P.M. Ditto.
6-X, 1 P.M. Ditto.
7-X. Both larvæ dead.

(6)

29-IX, 4-48 P.M. Enclosed in bottle 2 females (emerged from Pusa tree-hole materials I) and 1 small-sized male (bred from eggs deposited in captivity). Kept in incubator (28°C.).
1-X, 2-15 P.M. Introduced 2 more small-sized males. Changed raisins as they were covered over with fungus.
2-X, 3-15 P.M. Offered arm ; did not bite. Removed raisins.
4-X, 3-15 P.M. Offered arm ; did not bite, but 1 appeared attracted. (Temperature of room, 19°C.)
5-X, 4-30 P.M. Offered arm. 1 bit but was not fully gorged ; the other very sluggish and refused to bite even when made to settle on arm.
7-X, 1-19 P.M. 1 female seated on the filter paper.
8-X, 3 P.M. 1 only of the males alive.
11-X, 1-14 P.M. Male dead. Only 1 egg deposited.
12-X, 1-40 P.M. 2 more eggs found in water. 1 mosquito just deposited two clusters of eggs, one consisting of about 7 eggs, the other of 25 eggs, the former being deposited on the comparatively dry part of the filter paper, the other being stuck on to the leg of the mosquito. The mosquito did not respond when disturbed.
13-X, 3 P.M. Only 1 female alive.
14-X, 11-30 A.M. The female alive. No more eggs deposited.
16-X, 3-25 P.M. None of the eggs hatched.
18-X, 1 P.M. 1 larva seen ; it probably hatched on 17-X, as judged by its size.
19-X, 1-24 P.M. No further eggs hatched.
21-X 10-20 A.M. Many eggs hatched. Placed the young larvæ in water, previously used for rearing *albopicta* and which already contained dry flies, rice grains and pieces of the filter paper.

25-X. None pupated yet.

26-X, 4 P.M. Several pupated.

27-X, 2 P.M. 1 male and 1 female emerged.

29-X, noon. 2 females and 4 males emerged, all of good size and active. Probably a few emerged on 28-X, as judged by the number of dead mosqu'tos floating. No more larva or pupa left.

Summary of observations on the life-history of A. (S.) albopicta[1].

(*a*) The males were almost invariably the first to emerge.

(*b*) The minimum duration of the various stages was found to be approximately as follows :—

1. In the case of Pusa tree-hole materials :—

(i) At an average room temperature of about 21°C. :—

Incubation period, 18 hours (actually, probably less).
Larval priod, 8 days.
Pupal period, 3 days.

(ii) In incubator kept at 28°C. :—

Incubation period, 18 hours (actually, probably much less)
Larval period, 4 days.
Pupal period, 2 days.

2. In the case of mosquitos reared from eggs deposited in captivity :—

(i) At an average temperature of about 21°C. :—

Pre-oviposition period,[2] 7 days.
Incubation period, 8 days.
Larval period, 12 days.
Pupal period, 5 days.

(ii) In incubator kept at 28°C. :—

Pre-oviposition period, 3 days.
Incubation period, 3 days.
Larval period, 6 days.
Pupal period, 2 days.

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[1] A few attempts were made to induce *A.* (*S.*) *thomsoni* to oviposit in captivity, but they were unsuccessful. It is of interest that a few individuals of this species almost always emerged from the Pusa tree-hole materials after all the individuals of *A.* (*S.*) *albopicta* had been bred out therefrom.

[2] The expression " pre-oviposition period " is used here to mean the period between the first feed of blood and oviposition. As will be seen from the schedule of experiments, this period varied considerably, and this was what was to be expected, since such variation may have not only occurred as a result of intrinsic individual differences, but oviposition may have been delayed as a direct consequence of delayed pairing, although males were introduced into the cage at the very start of each experiment.

APPENDIX II.

Table of Meteorological Observations.

Date	June		July		August		September		October	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1	79·0	65·9	74·2	58·9	69·4	60·1	67·6	58·1	54·4	50·7
2	80·6	64·1	62·2	59·1	67·2	59·9	64·6	58·9	57·6	52·3
3	79·4	55·5	66·6	59·3	65·7	58·0	67·2	59·1	61·0	55·1
4	79·2	63·3	71·6	59·6	65·4	59·0	65·2	58·5	64·2	52·1
5	78·8	66·0	73·7	60·9	60·2	59·0	68·2	57·9	No re	cord.
6	80·5	67·1	68·6	59·3	60·2	56·5	No	record.	63·4	51·5
7	80·2	65·5	69·2	59·1	62·0	58·1	69·2	56·9	63·4	49·9
8	80·6	67·1	63·2	57·5	69·0	60·0	71·2	57·3	62·0	51·1
9	80·7	67·0	67·0	58·1	69·4	59·1	68·6	56·5	66·2	53·3
10	82·6	68·5	72·2	60·1	70·6	59·1	69·2	57·7	67·2	52·9
11	81·4	66·3	72·0	60·5	64·1	59·0	68·2	58·1	66·8	53·9
12	78·2	62·5	69·2	58·3	63·4	59·1	69·4	56·6	66·2	52·1
13	78·1	56·1	70·4	58·1	69·6	58·5	69·1	55·7	65·2	50·7
14	76·7	62·5	66·2	57·1	71·8	60·1	66·6	55·7	64·1	50·1
15	81·2	63·9	67·2	57·9	75·0	60·9	66·7	54·5	64·0	48·9
16	81·0	66·0	70·6	59·5	74·6	57·1	66·1	55·1	64·8	48·0
17	80·6	64·5	68·0	58·7	Not available.	Not available.	67·2	53·6	63·2	49·1
18	77·8	59·6	68·1	57·0	,,	,,	68·5	55·9	61·4	49·9
19	Not available	Not available	67·6	56·3	,,	,,	69·7	54·7	61·6	49·6
20	68·2	58·9	63·2	57·1	,,	,,	72·0	56·7	61·2	47·5
21	70·4	60·7	71·8	59·1	,,	,,	66·8	55·3	59·6	46·1
22	73·1	61·1	65·2	58·9	,,	,,	55·6	50·6	Not available.	Not available.
23	75·2	62·0	64·0	58·1	66·2	57·3	56·0	50·1	58·0	46·3
24	76·2	63·5	66·7	57·1	65·3	58·3	53·7	49·9	60·2	47·3
25	76·2	62·1	65·2	59·1	72·2	59·1	62·0	52·1	61·2	47·6
26	74·2	60·9	68·2	58·1	66·2	58·1	66·6	56·5	61·7	49·9
27	67·2	61·3	67·7	58·9	68·0	58·3	67·2	57·3	62·6	48·2
28	72·0	59·6	67·0	59·3	65·1	57·6	66·6	56·3	1·8	49·5
29	73·4	61·5	71·2	62·0	69·0	59·8	65·6	52·1	62·4	45·5
30	76·8	60·6	69·4	59·9	62·7	57·7	59·2	50·5	Experi	ments
31	Not available	Not availabl	e. 69·4	60·1	67·2	58·3	Not available.	Not available.	disco ..	ntinued. ..

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PART II.

Transmission of rinderpest by means of *Musca domestica*, Linn.

Few attempts appear to be on record to incriminate *Musca domestica* as an actual, as opposed to potential, carrier of disease. The charges against this fly would frequently appear to be based on evidence of a circumstantial character, there being almost complete lack of *data* on actual transmission experiments. *Primâ facie*, the indoor habits of the fly, and particularly the extent of access which it enjoys to almost every conceivable kind of food or filth, strongly suggest the possibility of these acting as intermediaries in the propagation of such common diseases as typhoid, cholera and dysentery. On the other hand, from a quantitative point of view, the numerical strength of the flies on the scene of the outbreak of a disease would frequently appear to be far in excess of the degree of virulence of the epidemic, and from this one would infer that the virulence of an epidemic does not, at any rate, proceed *pari passu* with the abundance of the flies. As a matter of fact, in the case of such diseases as are capable of being transmitted mechanically, there should be, obviously, at least more than one avenue of infection, and, as such, the *rôle* of flies in the mechanical transmission of such diseases should be, *a priori*, very limited.

Leaving aside the very numerous remarks of an *ex cathedrâ* character on the general complicity of *M. domestica* in the propagation of diseases, even the observations on the connexion of *M. domestica* with specific diseases (with the exception of habronemiasis) do not appear to be based on absolutely unequivocal grounds. In the case of such diseases as summer diarrhœa, dysentery, cholera and typhoid, no transmission experiments with *M. domestica* have been, for obvious reasons, ever attempted, and the possibility of the flies acting as intermediaries has been frequently solely deduced from the occurrence of the causative organisms in the invertebrate hosts, either on the surface of their body or within their intestinal tracts. Graham-Smith (1914) and Hewitt (1914) have adduced copious evidence of the presence of the causative organisims in the body of the invertebrate hosts, but very scanty reference occurs in their writings to actual transmission experiments having been carried out with *Musca*.

Coming to more recent works, reference may be made to the observations of Kling and Levaditi [1], who carried out a series of experiments on the fly transmission of poliomyelitis and obtained entirely negative results. Similar negative results were also obtained by Josefson, [2] although positive results ensued in a series of experiments carried out by Flexner and Clark, [3] but these were considered by Kling and Levaditi to be too artificial to be of value. The same remarks may

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[1] *Ann. Inst. Pasteur*, XXVII, pp. 718-749 (1913). The article contains several important references.

[2] *L'Institut Med. de L'État*, Stockholm, III, p. 169 (1912) [Referred to by Kling and Levaditi. l.c., p. 729.]

[3] *Jl. Amer. Med. Assoc.*, LVI, pp. 1717-1718 (10 June 1911).

perhaps be applied to the results of inoculation experiments carried out by Howard and Clark, [1] although they demonstrated the presence of the poliomyelitis virus in an active state for several days on the surface of the body and for several hours in the intestinal tract of *M. domestica.*

The experiments of Lebœuf [2] on the fly transmission of leprosy enabled him merely to demonstrate the presence of Hansen's bacilli in the flies and he *inferred* that tranmission through the agency of flies could possibly occur in the immediate neighbourhood of leprous patients. Bayon [3] is also of the opinion that the disease is usually communicated by immediate contact and that it is unlikely that an insect carrier is generally involved. Marchoux [4] found that infection occurred when the proboscides of the flies had only been recently soiled and also when bacilli from the intestine of the fly were introduced beneath the skin of rodents.

Messerschmidt [5] carried out a series of experiments in which twenty rabbits infected with "typhus [typhoid] bacilli" were confined in a cow-shed of 400 cubic feet containing approximately 800 flies. The results were all negative.

In testing the possibility of the fly transmission of yaws, Castellani "allowed *M. domestica* to feed (1) upon yaws material (scraping from slightly ulcerated papules), and (2) upon semi-ulcerated papules on the skin of these yaws patients. In both cases he was able to discover the *Spirochæta pertenue* in microscopic preparations made from the flies' mouth parts and legs. Furthermore, he allowed *M. domestica* to feed on yaws material (1 and 2 as above) and afterwards transferred them to scarified areas upon the eye-brows of monkeys. Of 15 monkeys thus experimented upon three developed yaws papules at the places which had been contaminated by the flies". [6] Bahr [7], however, has contested Castellani's view and points to the absence of correlation of the disease with the abundance of flies in certain infected localities in Ceylon.

Very recently, Lebailly [8] has published the results of a series of experiments on the possibility of the foot-and-mouth disease being spread through the agency of *M. domestica.* Cattle infected with the disease were housed in a stable adjacent to one containing healthy cattle, a small opening covered with wire-gauze serving as a channel of communication between them. Numbers of *Muscina stabulans* and *M. domestica* were introduced in both stables, the small opening permitting of their freely passing from one stable to another. Five experiments, each lasting 15 days, were carried out. The results were entirely negative.

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[1] *Jl. Exper. Med.*, XVI, pp. 850-859 (1912).

[2] *Ann. Hyg. Med. Colon.*, Paris, XVII, pp. 177-197 (1914). [Abstract in *Rev. App. Entom*, B, II, pp. 79-80 (1914).] Also, *Bull. Soc. Path. Exot.*, V, pp. 860-868 (1912).

[3] *Ann. Trop. Med. & Parasit.*, IX, pp. 60-61 (1915).

[4] *Ann. Inst. Pasteur*, XXX, pp. 61-68 (1916).

[5] *Centralbl. Bakt. Parasit. u. Infekt.* 1. Abt. Orig., LXXIV, pp. 1-5 (1914).

[6] Nuttall and Jepson. *Reports to the Local Govt. Board on Public Health and Medical Subject.* New series 16, No. 4, pp. 13-41 (1909). [Cited by Herms in *Medical and Veterinary Entomology*, p. 182 (1915).]

[7] *Ann. Trop. Med. & Parasit.*, VIII, p. 677 (1915).

[8] *C. R. Acad. Sci.*, CLXXIX, pp. 1225-1227 (1924).

As notable instances of diseases, besides habronemiasis, proved to be capable of being transmitted through the agency of *M. domestica*, mention may be made of anthrax, surra and a plague-like disease caused by *Bacterium tularense.*

As to the possibility of the insect transmission of anthrax, Morris [1] showed that *M. domestica* was capable of transmitting infection to wounds in healthy animals after feeding on flesh infected with anthrax bacilli or on discharges from open swellings.

In the case of surra, Mitzmain [2] found that the disease could be transmitted by *M. domestica* if applied on the abraded skin of the experimental animals. As Mitzmain's observations on the fly transmission of surra would appear to be the only extensive ones on the actual transmission of a disease through the agency of *Musca*, a few passages from his writings will bear quotation :—

" It is presupposed that the method is correlated with a previous skin abrasion affording the channel of entrance for the pathogenic organisms. Consideration of skin abrasions occurring through injury or disease must include the mechanical openings effected by various ectoparasites. The latter include such forms, as the ticks, gad flies and stable flies. It is obvious that in the presence of Muscids, with mouths constructed for lapping contaminated products, unlimited possibilities for conveyance of surra from host to host present themselves.

" It was aimed to prove, first, that this fly (*M. domestica*) could harbour infective organisms and was determined satisfactorily by numerous dissections and injections of saline suspensions of abdominal contents of flies fed on the abraded tail of the surra-infected monkey...........

" Attempts were made to simulate the normal relationship of parasitism in *M. domestica* and *S. calcitrans* by placing many flies of the two species in a common bottle and permitting them to attack the enclosed tail of a surra-infected monkey. Only laboratory-bred flies were employed.

" The five experiments were followed by negative results, demonstrating that under these conditions *M. domestica* does not transport infection through the channel afforded by the wound caused by the skin-piercing apparatus of *S. calcitrans*

" The possibility of surra infection being carried by the fly's feet was tested also. This was performed in the same manner as in the preceding, but with this difference : The infected flies were introduced from a separate bottle and by careful manipulation of the wire support attached to the monkey's tail the flies were permitted to alight on the appendage but were prevented from feeding.

" The five experiments failed to demonstrate that the wound made by the labium of the stable fly was a suitable channel for the introduction of trypanosomes carried on the pulvilli of *M. domestica.*

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[1] *Jl. Amer., Vet. Med. Assoc.* LVI, pp. 606-608 (1920).
[2] *New Orleans Medical and Surgical Journal,* LXIX, pp. 416-424 (1916-17).

"Finally, to serve as controls to these experiments, four tests were made to decide the question of the possibility of the punctures caused by the bite of the stable fly serving as sites for the introduction of trypanosomes in virulent blood. The four guinea-pigs used for the fly biting and the subsequent rubbing in of blood conveyed on a platinum loop escaped infection.

"The practical significance of the conveyance of trypanosomes obtained by *M. domestica* from the bite of the probing of the stable fly when wounds are present were finally investigated. Monkeys and horses were employed in this series. The house flies, after apparent engorgment of blood, derived from the probes of stable flies were transferred to clean bottles and the abraded surface of monkey's tail presented for the completion of the meal. The two horses exposed were scarified by scratching the haunch with a scalpel. Four of the five experiments attempted resulted in positive transmission."

With regard to *Bacterium tularense*, the causative organism of a plague-like disease in rodents, Wayson [1] found that washings of stable flies in normal salt-solution, when injected subcutaneously, produced positive results. "House flies used as mechanical porters in several trials proved capable of transferring infection from diseased viscera to healthy guinea-pigs. The bacteria were carried by the flies in their digestive tracts, mouthparts and dejecta, when immediately transferred to abrasion upon healthy rodents. Evidently the pulselli of contaminated house flies proved negligible as vehicles of infection. In four of the successful experiments flies were allowed to crawl on infected viscera, then induced to crawl on healthy conjuntiva prepared by cocanization and traumatized by rubbing sterile sand between the ocular and palpebral conjunctiva. This resulted, after 48 hours, in a purulent conjunctivitis, and after five to nine days, the death of the animals with cervical adenitis and typical lesions in the viscera."

From the foregoing references it would appear that although it is customary to incriminate the house-fly as an agent in the transmission of many diseases, particularly where bacterial as opposed to protozoal organisms are concerned, the actual *rôle* played by these insects in the propagation of diseases, under natural conditions, is very limited. Even in the case of such diseases as anthrax and surra, which have been definitely proved to be capable of being transmitted through the agency of *M. domestica*, such transmission has been shown to be only possible in the immediate neighbourhood of the infected animals. It would appear that the organisms, when ingested by the flies, remain viable usually only for a limited period within their alimentary tracts and rapidly attenuate whilst on the surface of the body of the flies. Bahr [2] found that the dysentery organism completely perished by the fifth day after its ingestion by the flies ; nor was he able to obtain any indication of the multiplication of these organisms in the body of the fly. Experiments

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[1] *Public Health Reports*, XXIX, pp. 3390-3393. [Abstract by M. B. Mitzmain in *Amer. Journ. Trop. Dis. & Prevent. Med.*, II, pp. 543-544 (1914-15).]

[2] *Brit. Med. Jl.*, pp. 294-296 (7 Feb. 1914).

conducted by Marchoux (*ante*) on the transmission of leprosy showed that the bacilli dried up whilst on the feet or proboscides of infected flies, and according to him the deposition of the bacilli along with excrement is of less common occurrence than is usually believed. In discussing the *rôle* of *M. domestica* in the propagation of amœbic dysentery and other intestinal protozoa, Roubaud [1] refers to the results of a series of experiments to prove that *M. domestica* can act as vector of certain intestinal protozoa under very limited conditions, particularly when their infected excrement is deposited on liquid or moist food. Root's [2] observations on the carriage of intestinal protozoa of man also point to the same conclusions, whilst Wollman [3] observed that flies infected with some of the common pathogenic organisms remained infective only for a few days. With regard to amœbic dysentery, Jausion and Dekester [4] remark that "the *rôle* of these flies in the transmission of *Entamœba dysenteriæ* is very limited," whilst in regard to *Giardia intestinalis*, the same authors observe that "the small and resistant cysts are undoubtedly well adapted to carriage by flies, but this does not conclusively prove that the infection is propagated by these insects."

It was considered that a series of experiments with *M. domestica* would definitely determine the possibility of the mechanical transmission of rinderpest and might also furnish indication with regard to the nature of the causative organism of the disease. The possibility of mechanical transmission seemed also to be indicated by the peculiar habit of the flies which—as one could not fail to notice in the cow-sheds at Muktesar—frequently sucked up the buccal and nasal discharges of infected animals and at the next moment crawled right up the nostrils of the animals and sometimes even regurgitated matter streaked with blood. The results of Shilston's experiments[5] on the vitality of the rinderpest virus would seem to indicate that the rinderpest organism is capable of causing the disease under conditions similar to those under which the virus may be transported through the agency of flies. A fair proportion of the present series of experiments was conducted with reference to the *data* recorded by Shilston, although the results were entirely negative.

I. Methods and material.

The earlier experiments, which merely aimed at finding out whether *M. domestica* was capable of harbouring the causative organisms in a virulent form, were carried out by means of caught specimens, but in the subsequent series laboratory-bred flies only were employed. The flies were very numerous at Muktesar during the months of May and June, when they constituted almost a pest in the dwelling-

[1] *Bull. Soc. Path. Exot.*, XI, pp. 166-171 (1918).
[2] *Amer. Jl. Hyg.*, I, pp. 131-153 (1921). [Abstract in *Rev. App. Entom.*, B, IX, p. 126 (1921).]
[3] *C. R. Acad. Sci.*, CLXXII, pp. 298-301 (1921). Also, *Ann. Inst. Pasteur*, XXXV, pp. 431-449 (1921).
[4] *Arch. Insts. Pasteur Afr. Nord*, III, pp. 154-155 (1923). [Abstract in *Rev. App. Entom.*, B, XI, p. 173 (1923).]
[5] *Mem. Dept. Agri. India, Vet. Ser.*, III, No. 1 (October 1917).

houses and cow-sheds. The nuisance continued almost unabated until the onset of the Rains when the flies gradually became less numerous, but seemed to increase again towards the middle of September and steadily decreased with the advent of the cold weather.

The specific identity of the insect vector is obviously of much less importance in the case of diseases considered to be mechanically transmitted than in the case of diseases where a developmental cycle of the causative organism in a specialized environmental host is supposed to be involved. In experimenting with any species of *Musca*, however, it would seem to be of importance to determine whether it represents one of the true indoor species (*e.g.*, *M. domestica, M. vicina* and *M. nebulo*) or one of the many hæmatophagous Muscids. The intermittent habit of feeding of hæmatophagous Muscids has caused them to be suspected as carriers of various diseases (such as murrina), [1] but as this presupposes the existence of wounds to serve as portals of entry of the parasites, the *rôle* of such flies in the propagation of diseases can only be very limited and they can enter as a factor of only minor importance in any extensive epidemic. On account of their much less specialized feeding habits, the indoor species of *Musca*, such as *M. domestica*, would seem to be more likely to transmit diseases mechanically, such as by settling on the mucous membrane or on the conjunctiva or by depositing excrement on to fodder.

In the present series of experiments, the flies were carefully compared with the description of the Oriental species of *Musca* as published by Patton, and were identified as *M. domestica*.

For the purpose of rearing, caught flies were confined in cages made of mosquito-netting, and fresh horse manure, collected almost daily in the early morning, was offered to the enclosed flies for oviposition, the manure being placed on sheets of paper spread on the bottom of the cages. At first, both sugar solution, as recommended by Patton and Cragg (*l.c.*, p. 345), and milk, as recommended by Dunn[1] were offered as food to the flies, but later on, only milk was used as being more handy and much less sticky, and the flies fell to it with apparent avidity and quickly engorged themselves with the material.

The manure was daily removed from the cages and examined for eggs, and when found, these were removed to small glass jars and placed on fresh manure for the emerging larvæ to feed upon. The larvæ were daily supplied with fresh manure and the deposition of mould on the manure was carefully avoided either by sunning the jars or by speedily removing, by means of forceps, any trace of mould that had just begun to form.

In accordance with the method recommended by Patton and Cragg (*l. c.*, p. 344), the jars containing full-grown larvæ were placed in a mud enclosure containing a thick layer of earth on its bottom, in order that the larvæ that would crawl out of the jars might find, in the course of their migration, a ready place in the earth for

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[1] Patton and Cragg. *A Text-book of Medical Entomology*, p. 733 (1913).
[2] *Bull. Ent. Res.*, XIII, pp. 301-305 (1923).

pupation. Experience showed, however, that, so far as this species of fly was concerned, the precaution was unnecessary, as the larvæ readily pupated within the jars, on the manure itself.

With the advent of the cold weather, metamorphosis was found to be much retarded under ordinary atmospheric conditions and recourse was therefore had to an incubator maintained at about 25°-30° C. for breeding the flies.

Three kinds of infective material were used, *viz.*, virulent blood, nasal discharge and fresh fæces, the materials being obtained from the animals at the height of the disease. A fresh supply of virulent blood was always in readiness at the Muktesar laboratory and the nasal discharge was obtained by swabbing the nostrils of infected animals by means of sterile swabs, whilst the small quantity of fæces that was needed could generally be obtained by gently scooping out matter from the anal meatus of affected animals.

For feeding the flies on blood, they were confined singly in tubes and the latter inverted over drops of blood placed on glass sheets, the tubes being gently tapped, if necessary, to bring the flies in contact with the blood. As this method frequently resulted in the flies, and sometimes the tubes themselves, being soiled with the infective material, a distinct improvement was effected when a piece of wire-gauze was made to intervene between the tube and the drop of blood. The gauze was kept gently pressed on the blood and a clean feed was usually secured by this method.

The necessity of the laborious process of feeding the flies singly arises, however, when in massive feeding it is dfficult to vouschafe whether any particular individual has fed or not. As the blood shows up well in the abdomen of an individual engorged with this material, the flies were usually fed on blood *en masse*, in bottles, except when individual feeding was specially called for for the purpose of any particular experiment.

For the reasons indicated above, the flies were fed singly when the infective material used was either nasal discharge or fæces; and as it was exceedingly difficult from the mere appearance of the abdomen, to obtain any indication as to whether an individual had fed or not, a careful and sustained watch was kept to make sure that it actually fed[1].

In feeding the flies *en masse* on blood, they frequently very persistently confined themselves to the bottom of the inverted bottle which enclosed them, and would not migrate to have a feed of blood unless kept hungry almost to the point of death. Under such conditions, advantage was taken of their heliotropic tendency by covering the bottle with a roll of pasteboard and placing the glass sheet containing the infective material on the top of the cloth cage. This cut off a considerable portion of the light but left the glass sheet sufficiently illuminated to induce the flies to settle on the blood.

[1] Unless, however, it is intended to test the infectivity of the vomit or the excrement of the infected flies, it is obviously immaterial whether the flies have actually ingested the infected material or not, as the mere contact of the proboscis with the infective material should be sufficient for the purpose of investigating the possibility of a mechanical transmission.

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The transmission experiments were carried out as follows [1] :—

(1) The flies were fed on virulent blood crushed on sterile mortar and inserted into pockets prepared beneath the skin of the experimental animals, in the region of the shoulders or the abdomen, the incision being subsequently stitched up.

(2) The flies were crushed in sterile normal saline solution, the emulsion filtered through a piece of wiregauze and the filtrate injected intravenously.

(3) Living infected flies were brought in contact with wounds, nasal mucous membrane and conjunctiva.

(4) Washings of infected flies were smeared on wounds, nasal mucous membrane and conjunctiva.

(5) Crushed feet and proboscides of infected flies were smeared on nasal mucous membrane and conjunctiva.

(6) Saline suspensions of infected materials were administered by drenching, or entire flies were given through the medium of fodder, the object being to test the receptivity of the buccal or the gastric mucous membrane for the causative organism. In this connection reference may be made to the fact that, according to Strickland,[2] rats may become infected with *Trypanosoma lewisi* by swallowing the invertebrate host (the rat flea) of this protozoon.

For collecting excrement, the infected flies were confined in sterile glass tubes and the fly " specks " deposited on the walls of the tubes were emulsified in normal saline solution with the aid of a sterile swab.

The incisions in the experimental animals were made by means of a sterile scalpel. At first, a dozen superficial incisions were made, but this resulted in a somewhat copious flow of blood which, on coagulation, seemed to block up the incisions. Later on, therefore, one or two superficial incisions only were made, these being gently opened afresh in the course of the experiments when the blood showed tendency to coagulate.

In bringing the flies in contact with the nasal mucous membrane and conjunctiva, pieces of mosquito-netting were found more convenient than glass tubes for enclosing the flies.

The interval between the infective feed and the contact of the infective flies with the experimental animals varied from one minute to about four hours. In the case of very short intervals, the flies were always fed singly and not allowed to have a full feed of the virulent blood (which was the only material used in such experiments) in order that they might settle readily on the abraded skin.

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[1] To kill the flies, chloroform was employed.

[2] Cited by Patton and Cragg. *L.c.*, p 736.

In the case of long intervals, the flies were kept enclosed in bottles, and to ensure a good supply of moisture moistened rags were kept hung up from the cotton wool that plugged the mouth of the bottle. In the later experiments, however, bottles were discarded in favour of cloth cages for confining the infected flies, as the inside walls of the bottles were sometimes found much bedewed with moisture which caused the flies to get stuck up or otherwise damaged. The flies were allowed feeds of milk but as a rule they were kept fasting as long as possible.

II. Schedule of experiments.

Series I. Subcutaneous insertion of crushed flies. Virulent blood used as infective material. Wild flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of inoculation	Interval between infective feed and inoculation	Result	Remarks
1	177 (Chupper 21)	161	11	14-V-24	26 hours	Positive	The flies included 2 dead ones.
2	177 (Chupper 21)	174	22	17-V-24	24 hours	Positive	The flies included 5 dead ones.
3	177 (Chupper 21)	170	23	21-V-24	31 hours	Positive	
4	178 (Chupper 22)	174	22	15-V-24	24 hours	Negative	
5	178 (Chupper 22)	176	10	18-V-24	24 hours	Negative	
6	239 (Chupper 61)	176	23	20-V-24	52 hours	Negative	All the flies were dead ones

Series II. Intravenous inoculation of saline suspensions (in normal saline solution) of crushed flies.

Virulent blood used as infective material. Wild flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of inoculation	Interval between infective feed and inoculation	Result	Remarks
1	246 (Chupper 24)	223	16	22-V-24	3 hours	Positive	•
2	246 (Chupper 24)	86	7	24-V-24	3 hours	Positive	Bull recovered
3	248 (Chupper 27)	223	13	23-V-24	3 hours	Positive	
4	268 (Chupper 39)	16	14	31-V-24	3 hours	Positive	
5	267 (Chupper 38)	16	15	31-v-24	6 hours	Positive	
6	267 (Chupper 38)	19	18	2-vi-24	6 hours	Positive	
7	331 (Chupper 43)	2	18	1-vi-24	7 hours		The animal died of hæmorrhagic septicæmia.
8	331 (Chupper 43)	17	20	3-vi-24	6½ hours		The animal died of hæmorrhagic septicæmia.

Series II. Intravenous inoculation of saline suspensions (in normal saline solution) of crushed flies—contd.

Virulent blood used as infective material. Wild flies employed—contd.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of inoculation	Interval between infective feed and inoculation	Result	REMARKS
9	265 (Chupper 34)	93	20	28-v-24	12 hours	Positive	
10	265 (Chupper 34)	16	12	31-v-24	12 hours		
11	266 (Chupper 35)	89	20	29-v-24	12 hours	Positive	
12	264 (Chupper 36)	20	16	30-v-24	12 hours	Negative	
13	255 (Chupper 31)	223	14	24-v-24	27 hours	? Positive	
14	255 (Chupper 31)	92	14	27-v-24	24 hours		
15	254 (Chupper 29)	86	15	25-v-24	24 hours	Negative	The flies included 6 dead ones.
16	254 (Chupper 29)	74	17	26-v-24	24 hours		
17	247 (Chupper 28)	75	12	23-v-24	50 hours	Negative	The flies included only 2 live ones.
18	247 (Chupper 28)	92	22	29-v-24	48 hours		
19	247 (Chupper 28)	16	15	2-vi-24	50 hours		
20	269 (Chupper 37)	89	12	31-v-24	51 hours	Negative	The flies included many dead ones.
21	269 (Chupper 37)	19	12	4-vi-24	48 hours		The flies included 7 or 8 either dead or moribund.

Series III. Intravenous inoculation of saline suspensions (in n. s.s.) of crushed flies.

Nasal discharge used as infective material. Wild flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of inoculation	Interval between infective feed and inoculation	Result	REMARKS
1	347 (Chupper 20)	328	22	7-vi-24	3 hours	Positive	
2	347 (Chupper 20)	110	18	10-vi-24	3 hours		
3	349 (Chupper 18)	169	11	9-vi-24	3 hours	Positive	
4	349 (Chupper 18)	338	21	13-vi-24	3 hours		
5	350 (Chupper 19)	328	23	8-vi-24	24 hours	Negative	Only 7 of these flies were alive.
6	350 (Chupper 19)	110	12	12-vi-24	24 hours		The flies included 2 dead ones.
7	352 (Chupper 17)	110	14	11-vi-24	24 hours	Negative	Only 2 of these flies were alive.
8	353 (Chupper 17)	338	22	15-vi-24	24 hours		The flies included 10 dead ones.

Series IV. Intravenous inoculation of saline suspensions (in n. s.s.) of crushed flies.

Fæces used as infective material. Wild flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of inoculation	Interval between infective feed and inoculation	Result	Remarks
1	409 (Chupper 26)	238	12	22-vi-24	3½ hours	Positive	
2	409 (Chupper 26)	178	23	25-vi-24	3 hours		
3	488 (Chupper 31)	178	20	24-vi-24	3 hours	Positive	
4	488 (Chupper 31)	407	14	26-vi-24	3 hours		
5	400 (Chupper 15)	120	9	18-vi-24	24 hours		All the flies were dead.
6	400 (Chupper 15)	226	12	20-vi-24	24 hours	Negative	The flies included a dead one.
7	400 (Chupper 15)	163	14	24-vi-24	27 hours		
8	405 (Chupper 9)	120	16	19-vi-24	24 hours	Negative	The flies included one dead and one moribund.
9	405 (Chupper 9)	238	12	21-vi-24	24 hours		The flies included 2 dead ones.

Series V. Smearing of crushed legs and proboscides (in n. s.s.) of infected flies on scarified skin.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of smearing	Interval between infective feed and smearing	Result	Remarks
1	340 (Chupper 41)	348	27	30-vi-24	4 hours	Negative	
2	340 (Chupper 41)	269	27	1-vii-24	3 hours		

Series VI. Smearing of crushed legs and proboscides (in n. s.s.) on nasal mucous membrane and conjunctiva.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of smearing	Interval between infective feed and smearing	Result	Remarks
1	334 (Chupper 46)	348	29	30-vi-24	4 hours	Negative	
2	334 (Chupper 46)	269	27	1-vii-24	3 hours		

Series VII. Intravenous inoculation of saline suspensions (in n.s.s.) of crushed legs and proboscides.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of inoculation	Interval between infective feed and inoculation	Result	REMARKS
1	335 (Chupper 47)	348	29	30-vi-24	4 hours	Negative	
2	335 (Chupper 47)	269	27	1-vii-24	3 hours	Negative	

Series VIII. Smearing of washings (in n. s.s.) of infected flies on scarified skin.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of smearing	Interval between infective feed and smearing	Result	REMARKS
1	341 (Chupper 48)	348	36	30-vi-24	4½ hours	Negative	
2	341 (Chupper 48)	269	22	1-vii-24	3 hours	Negative	

Series IX. Smearing of washings (in n. s.s.) of infected flies on nasal mucous membrane and conjunctiva.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of smearing	Interval between infective feed and smearing	Result	REMARKS
1	342 (Chupper 49)	348	36	30-vi-24	4½ hours	Negative	
2	342 (Chupper 49)	269	22	1-vii-24	3 hours	Negative	

Series X. Intravenous inoculation of washings (in n. s.s.) of infected flies.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Exprimental bull No.	Control No.	Number of flies	Date of inoculation	Interval between infective feed and inoculation	Result	REMARKS
1	343 (Chupper 50)	348	36	30-vi-24	4½ hours	Negative	
2	343 (Chupper 50)	269	22	1-vii-24	3 hours	Negative	

Series XI. Smearing of excrement (in n. s.s.) of infected flies on scarified skin.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of smearing	Interval between infective feed and smearing	Result	REMARKS
1	344 (Chupper 52)	490	39	2-vii-24	3 hours	Negative	About 13 fly "specks" which included several blood spots.
2	344 (Chupper 52)	269	61	3-vii-24	3 hours		

Series XII. Smearing of excrement (in n. s.s.) of infected flies on nasal mucous membrane and conjunctiva.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of smearing	Interval between infective feed and smearing	Result	REMARKS
1	345 (Chupper 53)	490	39	2-vii-24	3 hours	Negative	About 13 fly "specks" which included several blood spots.
2	345 (Chupper 53)	269	61	3-vii-24	3 hours		

Series XIII. Intravenous inoculation of saline emulsion of excrement of infected flies.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of inoculation	Interval between infective feed and inoculation	Result	REMARKS
1	346 (Chupper 5)	490	39	2-vii-24	3 hours	Negative	About 13 fly "specks" which included several blood spots.
2	346 (Chupper 5)	269	61	3-vii-24	3 hours		

N. B. About 40 fly "specks" including several blood spots were mixed with n. s. s. and one-third of th's emulsion was used in each of the above three experiments.

Series XIV. Oral administration (by drenching) of saline emulsion of excrement of infected flies.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of oral administration	Interval between infective feed and oral administration	Result	REMARKS
1	415 (Chupper 29)	522	12	7-vii-24	4½ hours	Negative	
2	415 (Chupper 29)	333	30	8-vii-24	4 hours	Negative	

Series XV. Oral administration (by drenching) of washings (in n. s.s.) of infected flies.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of oral administration	Interval between infective feed and oral administration	Result	REMARKS
1	249 (Chupper 27)	522	18	7-vii-24	4½ hours	Negative	
2	249 (Chupper 27)	333	20	8-vii-24	4 hours	Negative	

Series XVI. Contact of living infected flies with nasal mucous membrane or conjunctiva or both.

Virulent blood used as infective material. Laboratory-bred flies employed.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of contact	Interval between infective feed and contact	Result	REMARKS
1	339 (Chupper 24)	490	About 25	4-vii-24	3 hours	Negative	Contact could not be prolonged as the flies escaped owing to bull being turbulent.
2	339 (Chupper 24)	336	Not noted	5-vii-24	3 hours	Negative	
3	339 (Chupper 24)	336	12	6-vii-24	3 hours	Negative	
4	429 (Chupper 9)	530	30	11-vii-24	3½ hours	Negative	
5	429 (Chupper 9)	400	12	12-vii-24	2½ hours	Negative	

Series XVII. Contact of living infected flies with scarified skin.

Virulent blood used as injective material. Laboratory-bred flies employed.
Result : Negative.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of contact	Interval between infective feed and contact	REMARKS
1	1036 (Chup. 39)	490	About 35	4-vii-24	3 hours	The number of Experimental Bull represents number on horn.
2	1036 (Chup. 39)	336	Not noted	5-vii-24	3 hours	
3	1036 (Chup. 39)	336	18	6-vii-24	3 hours	
4	488 (Chup. 33)	405	10	17-vii-24	3½ hours	
5	488 (Chup. 33)	403	About 20	18-vii-24	3 hours	
6	563 (Chup. 32)	556	4	24-vii-24	1 hour	
7	563 (Chup. 32)	559	8	25-vii-24	1 hour	
8	563 (Chup. 32)	559	12	26-vii-24	1 hour	
9	563 (Chup. 32)	558	13	27-vii-24	1½ hours	
10	563 (Chup. 32)	558	15	28-vii-24	1 hour	
11	563 (Chup. 32)	556	7	29-vii-24	1½ hours	
12	563 (Chup. 32)	334	22	30-vii-24	1½ hours	
13	330 (Chup. 52)	340	19	31-vii-24	15 minutes	
14	330 (Chup. 52)	341	About 17	1-viii-24	15 minutes	
15	330 (Chup. 52)	342	About 17	2-viii-24	15 minutes	
16	330 (Chup. 52)	343	About 8	3-viii-24	15 minutes	
17	330 (Chup. 52)	343	About 9	4-viii-24	15 minutes	
18	1184 (Stable 1)	562	3	17-viii-24	1 to 2 minutes	The number of Experimental Bull represents number on horn.
19	1184 (Stable 1)	562	9	18-viii-24	1 to 2 minutes	
20	1184 (Stable 1)	560	12	19-viii-24	1 to 2 minutes	
21	1184 (Stable 1)	560	9	20-viii-24	1 to 2 minutes	
22	855 (Chup. 2)	590	9	29-viii-24	1 to 2 minutes	
23	855 (Chup. 2)	657	9	3-ix-24	1 to 2 minutes	
24	855 (Chup. 2)	688	5	7-ix-24	1 to 2 minutes	
25	855 (Chup. 2)	674	5	8-ix-24	1 to 2 minutes	
26	855 (Chup. 2)	688	10	9-ix-24	1 to 2 minutes	
27	855 (Chup. 2)	832	2	10-ix-24	1 to 2 minutes	
28	855 (Chup. 2)	697	8	13-ix-24	1 to 2 minutes	
29	855 (Chup. 2)	870	16	14-ix-24	1 to 2 minutes	
30	855 (Chup. 2)	912	15	15-ix-24	1 to 2 minutes	
31	855 (Chup. 2)	693	17	19-ix-24	1 to 2 minutes	

Series XVIII. Contact of living infected flies with nasal mucous membrane or conjunctiva or both.

Fæces used as infective material. Laboratory-bred flies employed.
Result : Negative.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of contact	Interval between infective feed and contact	REMARKS
1	253 (Chup. 44)	558	24	28-vii-24	1 hour	
2	253 (Chup. 44)	564	26	30-vii-24	1 hour	
3	253 (Chup. 44)	564	30	31-vii-24	1 hour	
4	253 (Chup. 44)	558	31	1-viii-24	1 hour	
5	253 (Chup. 44)	334	15	2-viii-24	1 hour	
6	253 (Chup. 44)	342	18	3-viii-24	1 hour	
7	253 (Chup. 44)	342	3	4-viii-24	1 hour	There were two more flies used in this expt. These had soiled themselves with infective material but were unfed.

Series XIX. Oral administration of entire infected flies (alive or killed immediately before administration) through the medium of fodder.

Virulent blood used as infective material. Laboratory-bred flies employed.
Result : Negative.

Serial No.	Experimental bull No.	Control No.	Number of flies	Date of oral administration	Interval between infective feed and oral administration	REMARKS
1	405 (Chup. 30)	333	11	9-vii-24	3 hours	
2	405 (Chup. 30)	530	12	10-vii-24	3 hours	
3	321 (Chup. 41)	559	12	26-vii-24	1 hour	
4	321 (Chup. 41)	558	13	27-vii-24	2 hours	
5	321 (Chup. 41)	558	15	28-vii-24	1½ hours	
6	321 (Chup. 41)	556	7	20-vii-24	1½ hours	
7	321 (Chup. 41)	334	20	30-vii-24	1½ hours	
8	321 (Chup. 41)	340	14	31-vii-24	45 minutes	
9	321 (Chup. 41)	341	15	1-viii-24	1 hour	
10	321 (Chup. 41)	342	17	2-viii-24	30 minutes	
11	321 (Chup. 41)	343	8	3-viii-24	30 minutes	
12	321 (Chup. 41)	343	10	4-viii-24	30 minutes	

PART III.

Transmission of rinderpest by means of the Cattle Louse, *Linognathus vituli*, Linn.

Although it was recognized that, from an epidemiological point of view, there were only very remote possibilities of rinderpest proving to be a louse-borne disease under natural conditions, it was considered that, in view of the existence of an immunological similarity between this disease and typhus,[1] the results of a series of transmission experiments by means of the common cattle louse might furnish indication as to the probable character of the causative organism of the disease.

I. Methods and material.

The experiments, which were of a very preliminary character, were designed with reference to the recent findings of Bacot and Ségal [2], and Atkin and Bacot, [3] regarding the conveyance of *Rickettsia prowazeki* by the body-louse, *Pediculus humanus*. Only seven experiments, divided into two series, were carried out :—

Series I. The lice were collected from infected animals, crushed on sterile mortar in sterile normal saline solution and the emulsion was injected intravenously into healthy animals.

Series II. The lice were collected from infected animals and transplanted alive on healthy animals, the object being to ascertain whether the disease could be caused through the bites of infected lice. So far as typhus is concerned, Bacot and his collaborators would seem to discredit the possibility of the disease being caused through the bites of infected lice and the results of their investigations would appear to indicate that it is in reality the excrement of infected lice that is infective, although they have hitherto been unable to advance a hypothesis as to the channel by which the parasites thus voided find their entry into the tissues of the vertebrate host. The existence of a previous abrasion to serve as a site for the introduction of the parasites can only be exceptional and can hardly be regarded as a factor of any importance in the ætiology of the disease. In the case of the louse-borne relapsing fever, it is generally agreed—and the hypothesis is supported by experimental evidence —that infection results from the crushing of the infected lice, whereby the liberated parasites usually find their entry through the epidermis beneath the nails. *Primâ facie*, this explanation would appear to be the only possible one, inasmuch as the spirochætes, once they are locked up in the haematocoele, can only be released as a result of the rupture of the invertebrate host. In the case of typhus, however, such a hypothesis would seem to be hardly indicated, since the punctures inflicted by the lice themselves may serve as portals of entry of the causative organisms voided with

[1] *Report of the Imperial Bacteriological Laboratory, Muktesar, for the two years ending the 31st March, 1924*, pp. 35-36 (1925).

[2] *Brit. Jl. Exptl. Pathology*, III, pp. 125-132 (1922).

[3] *Brit. Jl. Exptl. Pathology*, III, pp. 196-203 (1922). Also, other papers by Bacot and his collaborators.

the excrement. This possibility has been emphasized by Patton and Cragg [1] who observe : " Exit of the parasite per annum is probably a commoner and is certainly a more easily understood event. Infection in this case is dependent on the well-known habit of defaecation at the time of feeding, or immediately after it, which is to be observed in the great majority of blood-sucking insects. The excrement thus voided is of course in close approximation to the wound made by the mouthparts, and may mingle with the drop of blood which oozes out when the proboscis is withdrawn, so that there is ample opportunity for the parasite, especially if it is motile, to pass into the tissues of the invertebrate [*sic*,? vertebrate] through the wound." As, however, such contact of the infective excrement with the wound is obviously very largely a matter of chance, the *data* advanced by Bacot and his collaborators do not appear to be sufficiently copious to preclude the possibility of the disease being caused through the bites of infected lice.

II. Schedule of Experiments.

Series I. Intravenous inoculation of saline suspensions (in n. s.s.) of crushed infected lice.

Serial No.	Experimental bull No.	Control No.	Number of lice	Date of inoculation	Interval between removal from Control and inoculation	Result	Remarks
1	1183 (Stable 1)	563	25	17-viii-24	30 minutes	Positive	The number of Experimental bull represents number on horn.
2	1183 (Stable 1)	570	25	18-viii-24	15 minutes		
3	1183 (Stable 1)	560 and 671	125	19-viii-24	15 minutes		10 lice from Control 560; 25 lice from Control 671.
4	10 (Stable 1)	634	21	27-viii-24	3 hours	Negative	The number of Experimental bull represents number on horn.
5	1072	915	25	17-ix-24	30 minutes		

Series II. Transplantation of living lice.

Serial No.	Experimental bull No.	Control No.	Number of lice	Date of transplantation	Interval between removal from Control and transplantation	Result	Remarks
1	868 (Chupper 3)	682, 596 and 590	2+15+112 =129	1-ix-25	1½ hours	Negative	
2	868 (Chupper 4)	693	25	19-ix-25	30 minutes		

[1] *A Text-book of Medical Entomology*, p. 735 (1913).

M

Summary.

The transmission experiments recorded in this report resolve themselves into three categories :—

I. Transmission experiments by means of *Aëdes (Stegomyia) albopicta.*

These experiments were suggested by certain bacteriological findings obtained by the Director of the Imperial Institute of Veterinary Research, Muktesar, in the course of his investigations upon the ætiology of rinderpest, which seemed to indicate that the causative organism of the disease was, in many of its characteristics, probably not unlike *Leptospira icteroides*, the spiochæte incriminated with the causation of yellow fever and known to be transmitted by *A.* (*S.*) *argenteus.*

The results of the experiments on hill bulls were negative, but some of the rabbits experimented upon showed thermal reactions. Attempts were made to intensify these reactions by "passaging" through a series of rabbits the blood obtained from the originally infected (bitten) rabbits, but although pronounced reaction frequently resulted, the results were vitiated by an outbreak of pasteurellosis amongst the experimental animals. In the schedule of experiments, therefore, only such clinical charts are exhibited as represent results obtained by feeding infected mosquitos on rabbits. The results of "passaging" are withheld until such time as the experiments may be repeated under conditions precluding all possibility of supervention of pasteurellosis.[1]

II. Transmission experiments by means of *Musca domestica.*

The experiments of this series were carried out with the object of testing the possibility of the mechanical transmission of rinderpest through the agency of the house-fly. In a fair proportion of the experiments, positive results were obtained when bodies of flies fed on infective materials (such as virulent blood, nasal discharge and fæces of infected animals) were inoculated into susceptible bulls; but the results were negative when the experiments were conducted with reference to the natural conditions under which the disease was likely to be transmitted through the agency of *M. domestica.*

III. Transmission experiments by means of *Linognathus vituli.*

A series of experiments with lice was suggested by the existence of an immunological similarity of rinderpest to human typhus, the exciting agent of which is known to be transmitted by *Pediculus humanus.* The infectivity of saline suspen-

[1] Recent researches at Muktesar Laboratory upon hæmorrhagic septicæmia have been directed with the object of evolving methods of securing products for combating the disease, and the anti-serum now obtainable, when administered in the dosage recommended, is capable of warding off a virulent fatal infection.

sions of crushed infected lice was tested upon three bulls and of these one developed rinderpest. The results of transplantation of infected lice on a healthy bull were negative.

References are made in this report to certain aspects of the inquiry which, although they have no direct bearing on entomology, are nevertheless included here in order that the whole question may be presented in its true perspective. These aspects relate particularly to the conceptions involved in the expressions "developmental cycle" and "intermediary host" and to certain important features of the work done on arthropods as vectors of spirochætes. A brief review of the work done on yellow fever is also given inasmuch as the first part of the inquiry was conducted chiefly on the analogy of this disease.

Acknowledgments.

The writer desires to express his grateful thanks to Mr. J. T. Edwards, Director, Imperial Institute of Veterinary Research, Muktesar, for the many courtesies extended and for kindly criticism and much helpful guidance in the prosecution of the investigation.

The work of inoculation and "passaging" through rabbits was conducted by Mr. M. B. Menon, and the clinical observations on the experimental bulls were carried out under the supervision of Mr. J. D'Costa. To both these officers the writer's sincere thanks are due.

STUDIES ON INDIAN THYSANOPTERA.

BY

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(Received for publication on 31st August 1925.)

The present paper is a report on a collection of Thysanoptera from South India received by the author from Mr. Ramakrishna Ayyar and Rao Sahib Y. Ramachandra Rao, to both of whom he is much indebted for giving him the occasion to study this very interesting material. It adds considerably to the knowledge of the Thysanopterous fauna of India ; for, in this collection there are represented 50 different species, 18 of which are new to science and 4 must be considered as representing even new genera. The types are preserved in the author's collection, whilst available co-types were returned to the Agricultural Research Institute, Coimbatore.

The greater part of the present material was collected by Mr. T. V. Ramakrishna Ayyar whose name is well known to all students of Thysanoptera and who is the pioneer worker on this group in India. Already several years ago he sent valuable material to Mr. Bagnall and to Mr. Hood, both of whom have described some new species from his collections. Thus, it was especially valuable for me that I got from him also co-types or topotypes of these species for my studies. Moreover, he has now discovered many new species which will be described below. He may be congratulated on his great success in his work, and I hope that this will encourage him to continue his important studies on Thysanoptera in future also. Further, Rao Sahib Y. Ramachandra Rao has collected some Thysanoptera especially in Lantana flowers, in connection with his work on insects attacking Lantana. Finally, I also got some interesting specimens collected by Mr. A. G. Ramaswamiah and Mr. C. K. Subramanyam. All this material will be treated in the following paper, and the collectors' names are inserted with every species. Thus, I give here a practically complete record on the Thysanoptera known hitherto from South India for the present and I hope this paper will incite the Entomologists of India to collect further as many Thysanoptera as possible so that our knowledge thereon may be enriched again and again in future too. Especially owing to the ardent collecting work of Mr. Ramakrishna Ayyar, we know more on

Thysanoptera from South India than from most other tropical countries ; nevertheless, there can be no doubt that many new species would still be discovered in the future.

TEREBRANTIA.

LIMOTHRIPS CEREALIUM HALIDAY.

Head and prothorax of one specimen, from *Mimusops elengi*, August 3, 1923, Coimbatore ; probably occurred accidentally among many specimens of *Arrhenothrips ramakrishnae*, Hood ; A. G. Ramaswamiah coll. (T. V. R. No. 51.)

Maxillary palpi 2-segmented.

HYDATOTHRIPS RAMASWAMIAHI, N. SPEC.

(Plate XVI, figs. 1-3.)

♀, ♂. Head dark grey-brown, occiput behind the eyes well defined, yellow, with transverse net-sculpture. First and second antennal joints yellow, second somewhat darker than first ; third joint yellowish grey, not darker than the preceding ones ; fourth joint yellowish grey in basal third, beyond that dark grey ; following joints dark grey throughout. Disc of pronotum along sides and anterior margin yellow, with transverse net-sculpture ; remaining part of disc well defined dark grey-brown, strongly chitinized. Pterothorax dark grey brown above, especially in the middle region ; pleurae orange yellow. Sterna pale yellow around the coxae ; remaining part of mesosternum dark grey brown in posterior half, paler yellow brown in forepart ; metasternum on each side of the Y-suture with a large, transverse, well defined, very dark grey-brown patch, rest of it orange yellow, the space in the middle in front of the Y-suture lemon yellow. All coxae very dark grey-brown, femora brownish yellow, tibiae slightly paler, tarsi pale greyish yellow. Wings greyish infumate, hind pair especially so along median vein ; fore pair with a large hyaline cross band near base, distad from the scale. Abdomen brownish yellow, tergites slightly infumate, especially those of segments 2 and 3 ; seventh to ninth segments very dark brown, almost black ; apical segment somewhat paler brown.

Head much wider than long. Eyes somewhat protruding, occupying more than half the length of head. Ocelli arranged in an obtuse-angular triangle. Antennae (Fig. 1 a) slender ; 2nd joint ovate, strongly rounded, wider than the others. Sense cones of segments 3 and 4 united at base, of the usual horse-shoe shape and about half as long as the segments themselves.

Mouth cone bluntly pointed, extending slightly beyond the hind margin of prosternum. Maxillary palpi long, moderately slender, basal joint longer and thicker

than the others, apical joint longer and slightly narrower than second. Labial palpi much reduced, short and very thin.

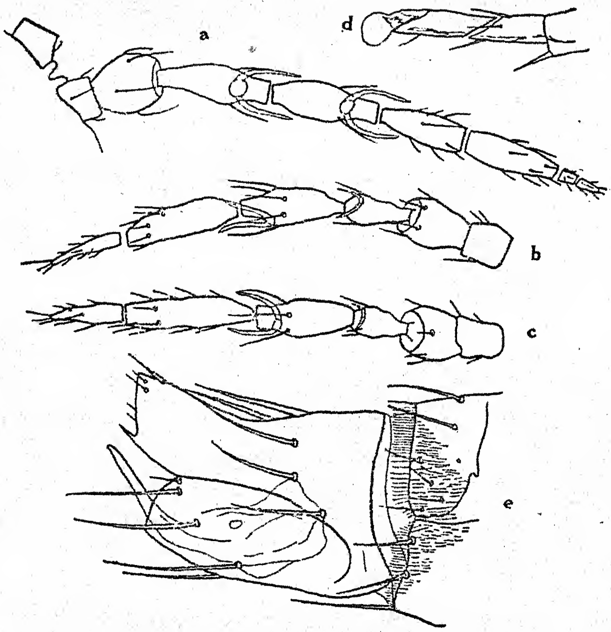

FIG. 1. *Hydatothrips ramaswamiahi*, n sp.—*a* normal antenna ; *b* anomalous antenna, ♂ ; *c* anomalous antenna, ♀ ; *d* hind tarsus, ♂ ; *e* end of ♂ abdomen, lateral view.

Prothorax longer and wider than head, rounded. No bristles near the angles. The strongly chitinized postero-median part with fine transverse striæ, visible only under high magnification, set with a few short, hair-like bristles on disc and along all margins.

Pterothorax hardly wider than long, fore and hind angles rounded, sides of mesothorax slightly arched, somewhat diverging backwards ; those of metathorax parallel. Mesoscutum with transverse striation, set with 6 bristles which are arranged on either half in the shape of an irregular triangle. Metascutum longitudinally striated and set, close to the fore margin, on either side, with two even longer and stronger bristles Mesosternum transversely truncate behind, with a sharp longitudinal suture along the entire length of the strongly chitinized mesosternal plate, which is crossed by a U-shaped endothoracic invagination. Sutures of metasternum Y-shaped, but the oblique branches of Y semi-circularly rounded, and the vertical, longitudinal shaft doubled.

All coxæ large, globose. Legs long and slender, especially the hind pair, with extraordinarily long, and articulately inserted tarsi (Fig. 1 d).

Wings reaching the penultimate or the apical abdominal segment, set with long fringe hairs along either margin ; entire surface densely clothed with very short

hairs, visible only under high magnification. Forewing broad in basal part, strongly constricted before the middle, where the foremargin is concave ; beyond that of equal width throughout up to the bluntly pointed apex. Fore margin set with about 25 bristles between the fringe-hairs ; only one longitudinal vein, set throughout the whole length with about 30 bristles ; in the pale cross band near the base is an interval of about 1 or 2 bristle-lengths. Scale with 4 bristles along fore-margin, and 1 on surface near base ; apex, as in *Megalurothrips setipennis*, with 2 sense-cone-like structures. Hind wings with one median vein, without bristles.

Abdomen wider than pterothorax in ♀, narrower in ♂ ; in ♀ less, in ♂ more than 2½ times as long as wide. Lateral parts only of the hind margins of the tergites 1-6, and the entire hind margins of pleurites set with dense comb-like fringes ; the entire surface of these sclerites densely clothed with fine, short hairs, except on the dorso-median region of each tergite ; on either border of this hairless region there is a backwardly directed bristle. Besides, there is near the middle of each tergite a pair of strong straight bristles, which are near each other on the basal segments and wider apart on the distal segments ; none of these bristles S-curved ! Tergites 7 and 8 fringed at hind margin along the whole width. Ninth and tenth segments (Fig. 1 e) without fringe, but furnished with some long, strong bristles in both sexes. Basal bows of ovipositor extending anteriorly to the middle of seventh segment.

Measurements ; ♀, ♂. Total length of antenna 0·28 mm. ; I. joint 0·02 mm. long, 0·023 mm. wide ; II. joint 0·035 mm. long, 0·027 mm. wide ; III. joint 0·06 mm. long, 0·02 mm. wide ; IV. joint 0·056 mm. long, 0·017 mm. wide ; V. joint 0·043 mm. long, 0·015 mm. wide ; VI. joint 0·052 mm. long, 0·014 mm. wide ; VII. joint 0·008 mm. long, 0·004 mm. wide ; VIII. joint 0·011 mm. long, 0·003 mm. wide. Head 0·07 mm. long, 0·15 mm. wide. Prothorax (incl. forecoxae) 0·13 mm. long, 0·20 mm. wide. Forefemora 0·14 mm. long, 0·045 mm. wide ; foretibiæ (incl. tarsi) 0·22 mm. long, 0·04 mm. wide. Pterothorax 0·23 mm. long, 0·25 mm. wide. Middle femora 0·14 mm. long, 0·04 mm. wide ; middle tibiæ (incl. tarsi) 0·24 mm. long, 0·035 mm. wide. Hind-femora 0·17 mm. long, 0·04 mm. wide ; hind-tibiæ (incl. tarsi) 0·32 mm. long, 0·04 mm. wide. Length of wings (without fringe) 0·7 mm. Abdomen ♀ 0·68 mm. long, 0·29 mm. wide ; ♂ 0·50 mm. long, 0·18 mm. wide. *Total length* ♀ 0·9-1·3 mm., ♂ 0·7-1·1 mm.

Described from several ♀♀ and ♂♂ taken at Coimbatore from Indigo leaves Sept. 6, 1923, by Mr. A. G. Ramaswamiah, in whose honour I have named it. **(T. V. R. No. 45.)**

Larva yellow, abdominal segments furnished with fan-shaped bristles.

TRYPHACTOTHRIPS MUNDUS, N. SPEC.

(Plate XVI, fig. 4.)

♀. Very similar in colour and morphological characters to the Sumatran *T. mediosignatus*, but without the dark, blackish infumation on tergite 1 and base of

tergite 2 ; the proportions of antennal segments (Fig. 2 a) are also somewhat different. Ocelli wider apart from one another than in *mediosignatus* ; surface of head between eyes with distinct, though irregular reticulation, occiput behind the eyes with widely separated transverse striæ. Palpi (Fig. 2 b) short and thin. Hind margin of prothorax with 8 short, rather equidistant bristles, which are neither longer nor stouter than those on dorsal surface of the disc. Mesoscutum with transverse, metascutum with longitudinally arranged net-sculpture. Wings coloured and bristled as in *mediosignatus*. Hind margins of abdominal segments without comb-like fringe. Tergites set with many short, thin, but strong bristles, as in *mediosignatus* ; only a narrow dorso-median longitudinal stripe is free from them, and smooth. Bristles of dorso-median pair wider apart from each other than in the preceding species, slightly curved and directed mesad ; on segments 2 to 4 short and hair-like, on segment 5 as long as the distance between their tips, on the following segments strong, slightly S-curved, much longer and crossing each other at the tips (Fig. 2 c) ; on segment 8 two pairs of such bristles present. By their shape and position they remind us of the wing-retaining spines of Tubulifera, especially of *Leeuwenia*, and may fulfill perhaps the same function (convergent adaptation !). All other characters as in *mediosignatus*.

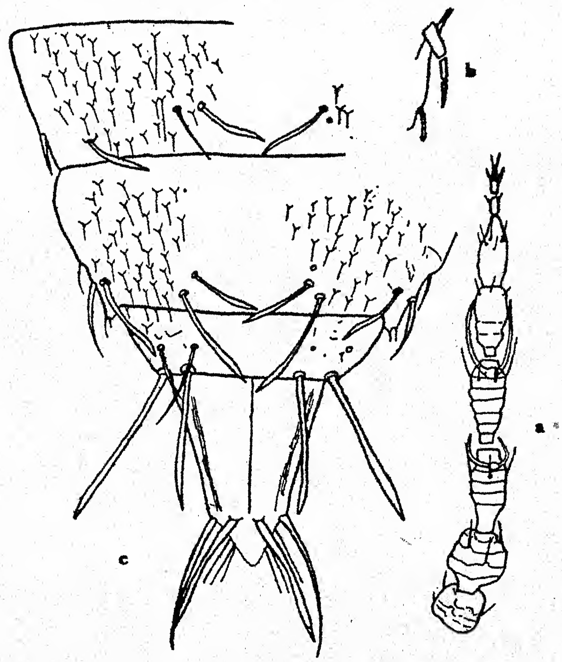

FIG. 2. *Tryphactothrips mundus* ♀ ; *a* antenna ; *b* palpi ; *c* end of abdomen.

Measurements, ♀. Total length of antenna 0·25 mm. ; I. joint 0·02 mm. long, 0·025 mm. wide ; II. joint 0·035 mm. long, 0·03 mm. wide ; III. joint 0·045 mm.

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long, 0·02 mm. wide; IV. joint 0·045 mm. long, 0·02 mm. wide; V. joint 0·04 mm. long, 0·017 mm. wide; VI. joint 0·04 mm. long, 0·013 mm. wide; VII. joint 0·01 mm. long, 0·005 mm. wide; VIII. joint 0·013 mm. long, 0·003 mm. wide. Head 0·09 mm. long, 0·15 mm. wide. Prothorax 0·12 mm. long, 0·19 mm. wide. Fore-femora 0·10 mm. long, 0·06 mm. wide; fore tibiæ (incl. tarsi) 0·15 mm. long, 0·04 mm. wide. Pterothorax 0·25 mm. long, 0·27 mm. wide. Middle femora 0·09 mm. long, 0·045 mm. wide; middle tibiæ (incl. tarsi) 0·14 mm. long, 0·04 mm. wide. Hind femora 0·14 mm. long, 0·055 mm. wide; hind tibiæ (incl. tarsi) 0·19 mm. long, 0·04 mm. wide. Length of wings (without fringe) 0·55 mm. Abdomen 0·75 mm. long, 0·30 mm. wide. *Total length* 1·0-1·2 mm.

Described from 5 ♀♀ taken at Taliparamba, Malabar, 16 September 1918, by Mr. Ramakrishna Ayyar, coll. No. XVI; causing small galls on leaves of a wild plant.

RHIPIPHOROTHRIPS CRUENTATUS, HOOD.

(Plate XVI, fig. 6.)

In the collection this species is represented by numerous specimens of both sexes from the following localities and food plants:—

Palur, S. Arcot, on leaves of *Odina odiar*, Octr. 1918; Ramakrishna Ayyar coll. No. XIX.—Maddur, Mysore, on leaves of *Eugenia jambulana*, Ramakrishna Ayyar 2 Septr. 1918, coll. No. XXI.—Coimbatore, on rose leaves, Aug. 3rd 1923, Y. Ramachandra Rao coll. No. 5. (T. V. R. No. 48.)—Coimbatore, on rose leaf, Aug. 3rd 1923, Y. Ramachandra Rao coll. No. 7.—Coimbatore, in *Calotropis* flowers, Feb. 15th 1924, Ramakrishna Ayyar coll. No. 39.—Coimbatore, on *Eugenia* leaves, Feb. 15th 1924, Ramakrishna Ayyar coll. No. 42.—Coimbatore, on grape vine leaf, Ramakrishna Ayyar coll. cotypes of material sent to Hood in 1916.—Lyallpur, Punjab, Afzal Husain, coll. No. 2146, April 24th 1923, from Imperial Bureau of Entomology.

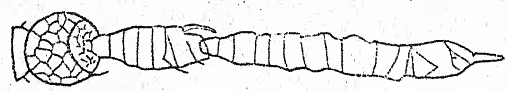

FIG. 3. *Rhipiphorothrips cruentatus* ♀, anomalous antenna.

Fig. 3 shows an anomalous antenna of a ♀ from No. 7 (on Rose leaf).

HELIOTHRIPS HAEMORRHOIDALIS BOUCHE.

Several specimens from Coimbatore and Bangalore, on leaves of garden crotons, "sometimes causing serious damage to the foliage," January 1921, Ramakrishna Ayyar coll. No. X.—1 ♀ from Coimbatore 18th August 1918, in shoots of "*nim*" (*Melia azadarichta*), Ramakrishna Ayyar coll. No. XI.

HELIOTHRIPS INDICUS, BAGNALL.

(Plate XVI, fig. 5.)

Several specimens from Bombay, on cabbage leaves, T. V. R. No. IX.

AYYARIA, N. GEN.

Body neither unusually slender, nor extraordinarily broad. Head not produced in front of eyes, occiput with some wide apart, partly confluent, transverse striæ. Antennæ long and very slender, 8-segmented, style much shorter than the preceding joint. Mouth cone of usual length and shape ; maxillary palpi 2-segmented. Thorax without net-sculpture. Prothorax with one long (anteromarginal) bristle, mesad from fore angle, and two similar ones near each hind angle ; anterolaterals, some bristles along lateral margin, and one pair near the middle of hind margin short ; remaining surface smooth, not clothed with short hairs. Fore tibiæ unarmed. Wings present, normally shaped ; fore pair with two rows of unusually long and strong bristles, arranged along the very inconspicuous veins. Lateral portions of abdominal tergites with distinct polygonal net-sculpture, though less strongly arranged than in *Heliothrips haemorrhoidalis*. Hind margin of segments entire, except on segment 8 where it is furnished with a strong comb-like fringe. Apical segments not unusually narrowed nor tubiform.

This new genus is named in honour of its discoverer, Mr. Ramakrishna Ayyar. It may be distinguished from the members of the Heliothripinæ by the long bristles of prothorax, and as such it must be placed in the Thripinæ. In this group, it agrees with *Diarthrothrips*, Williams in the two jointed maxillary palpi, but differs in having long anteromarginal bristles and the surface of prothorax not clothed with short hairs. This latter character distinguishes it also from *Parafrankliniella*, Priesner with which it agrees in the presence of very long bristles mesad from anterior prothoracic angles ; it also differs from the latter in having 2-jointed maxillary palpi. Thus, it cannot be confused with any of the hitherto known genera.

AYYARIA CHAETOPHORA, N. SPEC.

(Plate XVII, fig. 1.)

♀. General colour uniformly grey brown. First and second antennal joints darker than head, second slightly paler distad ; third to fifth joints very pale greyish, almost hyaline, third slightly shaded wth grey before apex, fourth grey—in preapical fourth, fifth in apical half ; sixth joint grey, with basal third nearly hyaline ; style grey. All femora slightly paler than the body, very pale yellowish grey at base and knee. Tibiæ and tarsi very pale yellowish grey, fore tibiæ infumate along both margins. Fore wings hyaline, with dark crossbands in second and fourth fifths.

Head with a pair of long bristles behind anterior ocellus, as in *Parafrankliniella* and *Diarthrothrips*. Postocular bristles practically wanting. Antennæ (Fig. 4 a) very slender and long. Joints one to five with moderately long, thick, stiff bristles; those on sixth and style shorter, hair-like. Sense-cones of joints 3 and 4 of usual shape, very thin, hardly half as long as the joints. Maxillary palpi (Fig. 4 b) 2-jointed, basal joint thicker and shorter than the apical one.

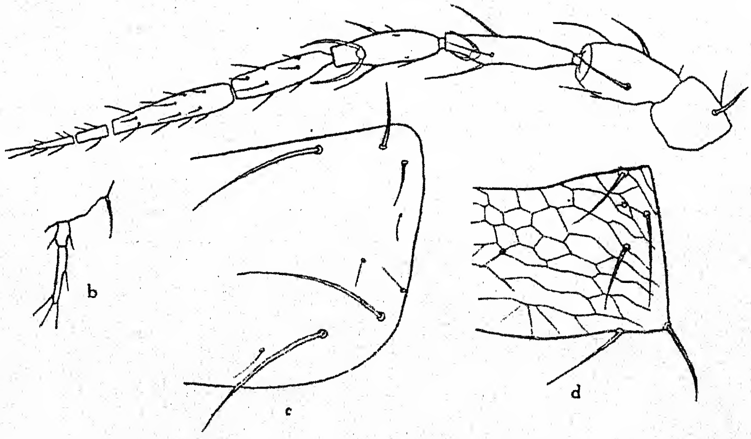

FIG. 4. *Ayyaria chaetophora*, n. gen. and spec. ♀; *a* antenna; *b* maxillary palpus; *c* chaetotax of prothorax; *d* chaetotaxy of third abdominal segment.

Prothorax (Fig. 4 c) as stated in the description of the genus. Wings reaching the hind margin of 8th abdominal segment, with long fringe along both margins. Bristles of fore wings very long and stout, conspicuously longer than breadth of the wing, those in the dark cross bands dark, the others pale. *Chaetotaxy:* costa 18; chief vein 10; lower vein 3, the first of which is in the middle of wing; scale 3 and the 2 sense-cones at apex as in *Hydatothrips ramaswamiahi*.

Abdominal segments (Fig. 4 d) structure and chaetotaxy as described for the genus. Apical half of 9th segment set with 3 cross-rows of long, stout bristles, reaching the apex of following segment. This latter segment is also provided with some similar, but slightly thinner, bristles of nearly the same length.

Measurements, ♀. Total length of antenna 0·38 mm.; I. joint 0·03 mm. long, 0·033 mm. wide; II. joint 0·05 mm. long, 0·03 mm. wide; III. joint 0·08 mm. long, 0·015 mm. wide; IV. joint 0·06 mm. long, 0·015 mm. wide; V. joint 0·055 mm. long, 0·015 mm. wide; VI. joint 0·07 mm. long, 0·013 mm. wide; VII. joint 0·017 mm. long, 0·007 mm. wide; VIII. joint 0·022 mm. long, 0·004 mm. wide. Length of head 0·13 mm., of prothorax 0·13 mm. Fore femora 0·15 mm. long, 0·06 mm. wide; fore tibiæ (incl. tarsi) 0·23 mm. long, 0·045 mm. wide. Length of pterothorax 0·16 mm. Middle femora 0·15 mm. long, 0·05 mm. wide; middle tibiæ (incl. tarsi) 0·23 mm. long, 0·045 mm. wide. Hind femora 0·18 mm. long, 0·05 mm. wide; hind

tibiæ (incl. tarsi) 0·34 mm. long, 0·045 mm. wide. Length of wings (without fringe) 1·0 mm. Length of abdomen 1·1 mm. *Total length* 1·5 mm.

1 ♀ from Taliparamba, Malabar, inside flowers of Cow-pea (*Vigna catiang*), Ramakrishna Ayyar coll. No. XXII, 18th Septr. 1918.

SCOLOTHRIPS 6-MACULATUS, PERGANDE.

2 ♀♀, 1 ♂ from Coimbatore, Sept. 1st 1923, on pomegranate flowers, A. G. Ramaswamiah coll. No. 4. (T. V. R. No. 47.) The specimens were compared with those from North America and Europe (in my collection).

FRANKLINIELLA SULPHUREA, SCHMUTZ.

(Plate XVII, fig. 2.)

There are, in the collection before me, many ♀ specimens (no ♂♂ !) of a *Frankliniella* which must be identified with Schmutz's species. From this material, I can complete Schmutz's description by giving the following characters :—

General colour of body sulphur yellow in pale specimens, orange yellow in dark specimens. Distal part of abdomen never darker than the pterothorax, usually even paler. Antennæ (Fig. 5) sometimes pale throughout, except the 6th joint and the style, which are always dark grey. 2nd joint as pale as the 1st, often slightly darker and greyish infumate, and sometimes abruptly ferrugineous at apical margin. Joints 3 to 5 usually more or less greyish infumate, especially distad, in the 3rd less, and in the 5th more than in the 4th. Length of bristles (in μ) : postoculars 25—30, anterolaterals 45—60, posterolaterals 60—70, those on penultimate abdominal segment 90—100. Wings reaching the 7th, 8th or even 9th abdominal segment, usually hyaline, sometimes slightly greyish infumate. Chaetotaxy of fore wings : costa 19—24, upper vein 17-20, lower vein 13—16.

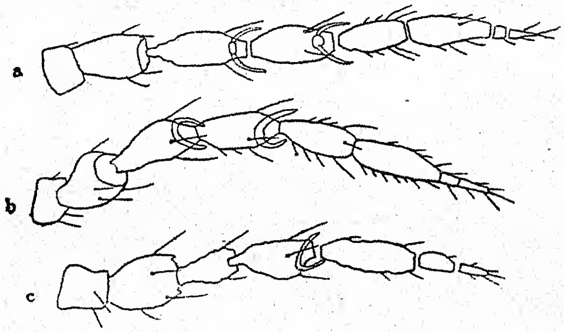

FIG. 5. *Frankliniella sulphurea* Schmutz; *a* normal antenna of a ♀ from *Lablab* ; *b* normal antenna of a ♀ from *Lantana* flowers ; *c* anomalous ("Ceratothripoid") antenna of a ♀ from *Crotalaria*.

Coimbatore, inside *Chrysanthemum* flowers, 13th August 1918, Ramakrishna Ayyar coll. No. XX.—Coimbatore, on *Lantana* flowers, Aug. 3rd 1923, Y. Ramachandra Rao coll. No. 1. (T. V. R. No. 44.) Coimbatore, *Bignonia grandis* flowers, Aug. 14th 1923, A. G. Ramaswamiah coll. No. 6. (T. V. R. No. 49.) Coimbatore, in lucerne flowers, Aug. 1923, Ramakrishna Ayyar coll. No. 24.—Coimbatore, in flowers of *Datura*, Septr. 1923, Ramakrishna Ayyar coll. No. 25.—Coimbatore, on *Hibiscus rosa-sinensis*, Septr. 1923, Ramakrishna Ayyar coll. No. 26.—Coimbatore, in lablab flowers, Feb. 15th 1924, Ramakrishna Ayyar coll. No. 41.

Taeniothrips distalis, Karny.

8 ♀♀ from Coimbatore, Feb. 15th 1924, on lablab flowers, Ramakrishna Ayyar coll. No. 41.

Taeniothrips longistylus, Karny.

(Plate XVII, figs. 3, 4.)

The only difference between this and the preceding species is the paler 3rd joint of antennæ ; thus, it is not improbable that *longistylus* may be no other than a colour variety of *distalis*.

General colour of ♂ practically as in ♀, but usually more or less paler ; very pale ♂♂ have a brownish yellow pronotum and abdomen, whilst head, pterothorax and apical abdominal segments (8 or 9 to 10) are darker brown.

One of the ♂♂ before me (Plate II, fig. 4) has both antennæ of ' Ceratothripoid " structure ; the same is the case with one antenna of 2 ♀♀, whilst the other one is normal.

It is not improbable that " *Frankliniella* " (!) *vitata*, Schmutz may be a paler specimen of *longistylus*, but this cannot be stated with certainty from the description only, because it is not sufficient, especially as to chætotaxy of wings.

Coimbatore, in red gram (*Cajanus indicus*) flowers, 3rd Jan. 1917 ; Ramakrishna Ayyar coll. No. V.—Coimbatore, in shoots of *Nim* (*Melia azadarichta*), 18th Aug. 1918, Ramakrishna Ayyar coll. No. XI.—Coimbatore, in sunnhemp flowers (*Crotalaria juncea*), 13th Sept. 1918, Ramakrishna Ayyar coll. No. XII.—Taliparamba Malabar, inside flowers of cow-pea (*Vigna catiang*), 18th Sept. 1918, Ramakrishna Ayyar coll. No. XXII.—Coimbatore, in lucerne flowers, Aug. 1923, Ramakrishna Ayyar coll. No. 24.

Physothrips minor, Bagnall.

(Plate XVII, fig. 5.)

This species, described already by Bagnall from Mr. Ramakrishna's material in 1921, is very similar, in general appearance, structure and colour of antennæ

and in chætotaxy of wings, to *Tæniothrips longistylus*, but is conspicuously smaller and without a hyaline cross band before apex of forewing.

ISONEUROTHRIPS ORIENTALIS, BAGNALL.

(Plate XVII, fig. 6 ; Plate XVIII, fig. 1.)

I can complete Bagnall's description from the material before me by the following characters :—

5th antennal joint usually paler at extreme base, rarely dark throughout. Chætotaxy of forewings: costa 25—32 ; chief vein 17—18, *viz.*, 4+3+10—11, the distance between 3 and 10—11 about one bristle length or somewhat less, that between 4 and 3 still shorter ; lower vein 16—19, in ♂♂ usually less, sometimes 11 or 12 only ; scale 4 along fore margin, 1 on surface near base, 1 at apex. Colour of fore wings grey throughout, except a small, oblong-ovate, hyaline dot behind the space between the 3 and 10—11 bristles. Abdomen more or less linear in ♂, in ♀ varying in shape, usually more or less oblong-ovate, sometimes linear ; thus, the shape of abdomen cannot be used as specific character. ♂ abdomen, besides the pale areas described by Bagnall, furnished with two very long, curved, thick, dark, horn-like preapical bristles.

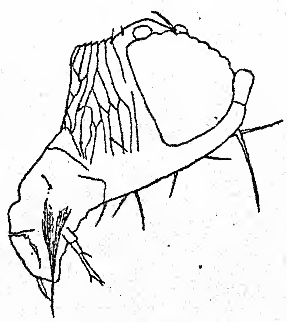

FIG. 6. *Isoneurothrips orientalis*, ♂ Lateral view of head.

Differing from *australis* by the dark colour (in both sexes !), from *setifer*, *parvispinus* and *jenseni* by the forewings being not hyaline in basal part, from *multispinus* by much shorter interocellar bristles, from *parvispinus, jenseni, multispinus* and *australis*, moreover, by the long head.

Three of the specimens before me show an anomalous antenna, as figured above for *Hydatothrips ramaswamiahi* (Fig. 1 b, c) and *Frankliniella sulphurea* (Fig. 5 c), but with the style shorter, 1-jointed, or entirely absent.

Numerous specimens in this collection from : Coimbatore, in flowers of *Morinda tinctoria*, 30th Apr. 1919, Ramakrishna Ayyar coll. No. VI.—Coimbatore, in flowers of Jasmine, Septr. 1923, Ramakrishna Ayyar coll. No. 27.

The species was known hitherto only from Sarawak.

THRIPS FLORUM, SCHMUTZ.

(Plate XVIII, figs. 2, 3.)

For synonymy see : Karny, *Ark. Zool.*, XVII A, 2, p. 13 ; 1924.

From the abundant material now before me, I can complete Schmutz's description as follows :—

♀.—Freshly emerged specimens orange yellow to ferrugineous, apical segments of abdomen always darker, grey brown ; then the whole abdomen becomes dark brown, head and thorax dark orange brown ; finally the whole body dark throughout. Antennæ uniformly dark, except the paler 3rd joint. Cheeks sculptured as in *kikuyuensis*. 8th abdominal segment as in *Kakothrips* or *Isoneurothrips*. Fore wings dark throughout or becoming slightly paler basad ; chief vein distad with 3 bristles, very rarely (1 ♀ and 1 ♂ in the whole material before me) 4.

♂ (" *Thrips sulphurea*," Schmutz).—Pale sulphureous to greyish or orange yellow. First and second antennal joints whitish hyaline, 2nd sometimes slightly darker, greyish. Following joints greyish, gradually becoming darker ; in dark specimens uniformly coloured, in pale specimens joints 4 and 5 paler in basal part than distad. Cheeks without distinct sculpture. Wings yellowish hyaline or slightly greyish ; chætotaxy as in ♀.

Some of the specimens before me show anomalous antennæ. In one antenna, there are joints 3+4 and 5+6, respectively, grown together. " Ceratothripid " antennæ are not uncommon : 3rd joint much smaller than usual, 4th of usual shape, then follows one joint shaped as the normal joint 6, then the normal style. This abnormality in one antenna occurs in several specimens, whilst the other antenna is quite normal. 1 ♂ and 1 ♀, however, have both antennæ of " Ceratothripid " structure ; thus, they should be placed in the " family *Ceratothripidæ*," but there cannot be any doubt that this family cannot stand, as it includes only Thripidæ with both antennæ anomalous.

Coimbatore, from the following food plants :—No. XII and XIV, sunn hemp flowers (*Crotalaria juncea*), and *Cumbu* ears (*Pennisetum typhoideum*), 13th Sep. 1918, Ramakrishna Ayyar coll.—No. 1, (T. V. R. No. 44) flowers of *Lantana*, Aug. 3rd 1923, Y. Ramachandra Rao col.—No. 2, on Indigo leaves, Sept. 6th 1923, A. G. Ramaswamiah coll.—No. 4, (T. V. R. No. 47) Pomegranate flowers, Sept. 1st 1923, A. G. Ramaswamiah coll.—No. 6, (T. V. R. No. 49) *Bignonia grandis* flowers, Aug. 14th 1923, A. G. Ramaswamiah coll.—No. 26, in flowers of *Hibiscus rosa-sinensis* Septr. 1923, Ramakrishna Ayyar coll.—No. 27, in Jasmine flowers, Sept. 1923, Ramakrishna Ayyar coll.—No. 37, from *Cæsalpinia pulcherrima* flowers, Sept. 23rd 1923, A. G. Ramaswamiah coll. No. 40, in Banana flowers, Feb. 15th 1924, Ramakrishna Ayyar coll.—No. 41, in Lablab flowers, Feb. 15th 1924, Ramakrishna Ayyar coll.—Further from Maddur, Mysore, on leaves of *Eugenia jambulana*, 2nd Septr. 1918, Ramakrishna Ayyar coll No. XXI, 1 ♀.

THRIPS PALMI, KARNY.

4 ♀♀ from Coimbatore, Feb. 15th 1924, Lablab flowers, Ramakrishna Ayyar coll. No. 41.

THRIPS TABACI, LINDEMAN VAR.

The few specimens before me differ from the typical *tabaci* by having only three distal bristles on upper vein of fore wing, as is also the case in Priesner's European varieties *flavosetosus* and *brevicornis* differing from *palmi* especially by the fifth antennal joint being pale basad.

4 ♀♀ from Coimbatore, in flowers and shoots of cotton, March 1920, Ramakrishna Ayyar coll. No. XV.—1 ♀ from Bombay, on cabbage leaves, No. IX.

THRIPS PARVUS, SCHMUTZ.

1 ♀ from Coimbatore in *Cæsalpinia pulcherrima* flowers, Sept. 23rd 1923, A. G. Ramaswamiah coll. (T. V. R. No. 37).

KEY TO THE SPECIES OF *MYCTEROTHRIPS*.

1. Lower vein of forewing with 10 or more bristles .	2.
General colour orange yellow. Upper vein of forewings with 7(4+3)+3 bristles, lower vein only with 4 in all. (India).	*M. setiprivus*, n. sp.
2. Apex of ♀ abdomen more or less conical. Upper vein of forewings in distal part with 4 bristles at least. (North America)	3.
Apex of ♀ abdomen broadly rounded. General colour whitish yellow. Upper vein of forewings with 8+2 bristles, lower vein with 14. (South Africa)	*M. laticauda* Trybom.
3. General colour bright yellow. Upper vein of forewing with 19 bristles, lower vein with 22	*M. floridanus* Watson.
General colour brown. Upper vein of forewings with 7(3+4)+4 bristles, lower vein with 10 . . .	*M. longirostrum* Jones.

It is worthy of mention that all these four species of the genus were taken only from leguminous plants. (*Papilionaceæ*) and *Acacia* (*Mimosaceæ*). ♂♂ not yet known.

Mycterothrips setiprivus, n. spec.

(Plate XVIII, fig. 4.)

♀. Orange yellow, pterothorax somewhat darker than head and abdomen; tarsi paler yellowish. Ocelli with red pigment-cups. Wings uniformly greyish yellow, infumate, not cross-banded. First antennal joint pale greyish yellow, 2nd joint slightly more yellow; 3rd still darker yellow; 4th and 5th joints dark greyish yellow in basal half, dark grey distad; 6th joint and style very dark grey throughout.

Head slightly wider than long, obtuseangulately produced between antennæ, lateral margins slightly arched, converging backwards; about as long as the eyes. Anterior ocellus directed forwards; posterior ones nearly touching it and the inner margin of eyes, widely separated from each other. Eyes black, not protruding. Cheeks obtuseangulately produced close behind eyes, bearing here a very short post-ocular bristle (shorter than the diameter of an ocellus), further back smooth, not serrate. Occiput with some indistinct transverse striæ.

Antennæ (Fig. 7 a) hardly twice as long as head. First joint cylindrical, as long as wide; second joint broadly ovate, wider than all the others, one and a half times as long as the first; 3rd and 4th joints broadly clavate, 5th truncate at apex; 6th joint fusiform; style not very long, apical joint longer than the basal one.

Bristles of joints 2 to 5 longer and stouter than usual. Sense-cones of usual shape, on 3rd and 4th joint reaching somewhat over the tip of the distal bristles.

Mouth-cone (Fig. 7 b) very much tapering distad, long and pointed, extending beyond the hind margin of prosternum. Maxillary palpi three-segmented, long and not very slender, not reaching the hind margin of prosternum; first joint longer and thicker than the following ones, 2nd shorter and thicker than the 3rd. Labia palpi small, about as long as and half as wide as the 2nd maxillary palpa joint.

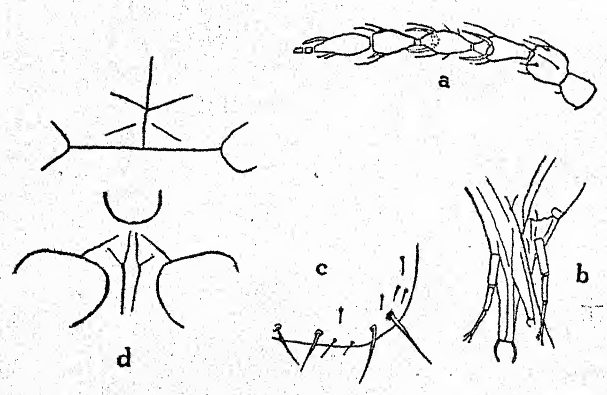

FIG. 7. *Mycterothrips setiprivus*, ♀, *a* antenna; *b* mouth cone; *c* hind part of prothorax, chaetotaxy; *d* structures of meso and metasternum.

Prothorax somewhat longer and wider than head, with two stout bristles near the hind angles ; these are about one fourth or fifth of the whole prothorax in length (Fig. 7 c). Between them along the hind margin are 6 short bristles, the median pair being the longest. Anterior angle with a short, forward directed bristle ; and some similar bristles, backwardly directed, are found all over the whole surface, especially along lateral margins. All these bristles not longer than the shorter ones of hind margin.

Pterothorax somewhat longer than wide, with sides of each segment arched. (Sternal sutures Fig. 7 d). Legs stout, unarmed ; hind tibiæ rather long.

Wings reaching the seventh abdominal segment, the whole surface closely set with very short hairs which are visible under high magnifications only. Bristles of veins about half as long as the width of wings near the middle, those on fore margin slightly longer. Chætotaxy : costa about 25 ; chief vein 7 basad (4+3), 3 distad ; lower vein 4 in all, the first of which inserted close behind the last premedial bristle of upper vein. Hind wings much narrower than the fore pair, with an indistinct median longitudinal vein.

Abdomen somewhat wider than pterothorax, two and a half times as long as wide, conically pointed at apex. Bristles moderately long and thin. Those on penultimate and apical segments thick and stout, dark brown, and about as long as the last segment itself.

Measurements : Total length of antenna 0·21 mm.; I. joint 0·02 mm. long, 0·02 mm. wide ; II. joint 0·03 mm. long, 0·023 mm. wide ; III. joint 0·04 mm. long, 0·015 mm. wide ; IV. joint 0·038 mm. long, 0·017 mm. wide ; V. joint 0·03 long, 0·014 mm. wide ; VI. joint 0·038 mm. long, 0·013 mm. wide ; VII. joint 0·006 mm. long, 0·005 mm. wide ; VIII. joint 0·010 mm. long, 0·003 mm. wide. Head 0·11 mm. long, 0·12 mm. wide. Prothorax 0·14 mm. long, 0·17 mm. wide. Fore femora 0·08 mm. long, 0·05 mm. wide ; fore tibiæ (incl. tarsi) 0·13 mm. long, 0·03 mm. wide. Pterothorax 0·24 mm. long, 0·20 mm. wide. Middle femora 0·07 mm. long, 0·035 mm. wide ; middle tibiæ (incl. tarsi) 0·11 mm. long, 0·03 mm. wide. Hind femora 0·11 mm. long, 0·04 mm. wide ; hind tibiæ (incl. tarsi) 0·20 mm. long, 0·03 mm. wide. Length of wings (without fringe) 0·50 mm. Abdomen 0·60 mm. long, 0·24 mm. wide. *Total length* 1·1 mm.

1 ♀ from Coimbatore, in shoots of a wild legume, August 1923, Ramakrishna Ayyar coll. No. 32.

ANAPHOTHRIPS OLIGOCHAETUS, N. SPEC.

(Plate XVIII, fig. 5).

♀, ♂. Pale yellow, legs still paler, wings very pale greyish, almost uniformly hyaline. The margins between abdominal segments 3 to 7 very narrowly brown in ♀, concolourous in ♂. Antennal joints 1 and 2 whitish hyaline, 3rd uniformly greyish, 4th darker, 5th to style very dark brownish grey.

Head wider than long, with sides converging backwards; fore margin above either antennal insertion roundly emarginate and between them obtuseangulately produced. Eyes black, somewhat protruding, shortly pilose between the facets, longer than the cheeks.

Antennæ slightly more than twice as long as the head, joints not very slender (Fig. 8). 2nd joint broadly rounded, much wider than all the following ones. 5th truncate at apex, broadly united with 6th. Bristles on second joint long and stout, weaker on the following ones. Sense-cones of 3rd and 4th joints moderately long, much shorter than in the tea-inhabiting species (*theiperdus* &c.).

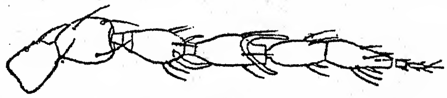

FIG. 8. *Anaphothrips oligochaetus*, n. sp., ♀, antenna.

Mouth-cone triangular more or less equilateral rounded at apex, not reaching the hind margin of prosternum. Maxillary palpi moderately long, 3-segmented; joints about equal in length, decreasing in width from 1 to 3. Labial palpi short and slender, not longer and even narrower than the apical joint of maxillary palpi.

Prothorax clothed with some short bristle-hairs; those at the hind angles stronger than the others and in length about one-fifth of the prothorax. Fore legs set with dark bristles almost all over the surface; femora somewhat incrassate, tibiæ and tarsi unarmed.

Pterothorax as long as wide or slightly longer. Sides of meso-and metathorax arched, the former being wider than the latter. Sternal sutures practically as in *Mycterothrips setiprivus*. Chætotaxy of middle and hind legs as stated above for the fore legs.

Wings reaching abdominal apex. Bristles of fore pair hardly half as long as the wing-width near the middle, those along fore margin longer and stronger. Chætotaxy: costa 22—28, upper vein (3—4+4—7)+(1+2); lower vein 1 to 2 in distal part; scale 3—4 along fore margin, 1 on surface basad, 1 at apex.

Bristles of abdomen moderately long and stout, those on segments 9 and 10 longer than the apical segment itself. Basal bows of ovipositor not quite reaching the hind margin of 7th segment. 9th segment longer than the others, 10th rounded at apex in both sexes.

Measurements; ♀, ♂: Total length of antenna, 0·19 mm.; I. joint 0·018 mm. long, 0·018 mm. wide; II. joint 0·03 mm. long, 0·02 mm. wide; III. joint 0·033 mm. long, 0·014 mm. wide; IV. joint 0·033 mm. long, 0·014 mm. wide; V. joint 0·028 mm. long, 0·013 mm. wide; VI. joint 0·034 mm. long, 0·012 mm. wide; VII. joint 0·006 mm. long, 0·006 mm. wide; VIII. joint 0·009 mm. long, 0·004 mm. wide. Head 0·08 mm. long, 0·11 mm. wide. Prothorax 0·10 mm. long, 0·14 mm. wide. Fore femora 0·10 mm. long, 0·035 mm. wide; fore tibiæ (incl. tarsi) 0·14 mm. long,

0·03 mm. wide. Pterothorax 0·17 mm. long, 0·16 mm. wide. Middle femora 0·09 mm. long, 0·03 mm. wide ; middle tibiæ (incl. tarsi) 0·12 mm. long, 0·025 mm. wide. Hind femora 0·11 mm. long, 0·025 mm. wide ; hind tibiæ (incl. tarsi) 0·18 mm. long, 0·025 mm. wide. Length of wings (without fringe) ♀ 0·65 mm., ♂ 0·40 mm. Abdomen ♀ 0·50 mm. long, 0·18 mm. wide ; ♂ 0·40 mm. long, 0·12 mm. wide. *Total length* ♀ 0·6—0·9 mm. ; ♂ 0·7 mm.

4 specimens from Coimbatore, *viz.*—In flowers and shoots of cotton, March 1920, Ramakrishna Ayyar coll. No. XV, 1 ♂, 1 ♀.—In Pomegranate flowers, Sept. 1st 1923, A. G. Ramaswamiah coll. No. 4, (T. V. R. No. 47.) 1 ♀.—From *Cæsalpinia pulcherrima* flowers Sept. 23rd 1923, A. G. Ramaswamiah coll. No. 37, 1 ♀.

This new species belongs to the *loennbergi*-group on account of the presence of posterolateral bristles. It seems to come nearest to the African *loennbergi*, but differs in having 2 bristles only on lower vein, whilst there are 4—5 in *loennbergi*, and by the antennal joints 3 to 6 being shorter ; moreover, in *loennbergi* joint 6 is shorter than 3, in *oligochaetus* it is longer. Further, there is *nubicus*, which agrees closely with *oligochaetus*, differing, however, in having 12 bristles on lower vein. The chætotaxy of fore wings in *oligochaetus* agrees very well with the Sumatran *andreae*, but the latter differs, amongst other characters, at once, by the dark forewings. The same is the case with *sumatrensis* and *theivorus*, in which the chætotaxy is also different. The tea-inhabiting species (*theiperdus*, *theivorus*, *theifolii*) have much longer sense-cones on antennal joints 3 and 4, and a different chætotaxy of the forewings. *A. theiperdus*, moreover, does not belong to the *loennbergi*-group as it has no posterolateral bristles.

Anaphothrips ramakrishnai, n. spec.

(Plate XVIII, fig. 6).

♀, ♂.—General colour as in the preceding species, but abdomen without darker transverse lines. 1st antennal joint whitish hyaline, 2nd slightly darker greyish yellow ; joint 3 to 5 pale greyish, 3 very slightly smoky before apex, 4 and 5 distinctly infuscated in apical third ; basal half of 6th pale greyish, apical half and style darker greyish.

Head wider than long, sides parallel ; fore margin nearly straight. Eyes not protruding, hardly as long as the cheeks. Antennæ (Fig. 9), especially joint 2, somewhat more slender than in *oligochaetus*. Sense-cones of joint 3 and 4 short. Mouth cone pointed, otherwise as in the preceding species. Maxillary palpi smaller ; relative length and width of the joints the same as in *oligochaetus*. Labial palpi as long and wide as the apical joint of maxillary palpi.

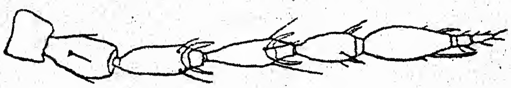

FIG. 9. *Anaphothrips ramakrishnai*, n. sp., ♀, anetnna.

Prothorax as in the preceding species, but with two strong bristles near each posterior angle; these are about three times as long as the other bristles on the thorax and nearly one third of the whole prothoracic length. On the hind margin, near the middle there is another pair of bristles, nearly as strong as the posterolaterals and fully one and a half times as long as the short surface-bristles. Pterothorax practically as in *oligochaetus*. Bristles of legs arranged as in the latter, but they are hyaline, not dark, and therefore much less conspicuous.

Wings reaching the 7th or 8th segment in ♀, the 9th in ♂. Bristle length as in the preceding species, number: costa 22—28, upper vein (4—5+4)+2; lower vein 12—15 in a continuous row; scale 4—5 on fore margin, 1 on surface near base, 1 at apex.

Abdomen practically as in *oligochaetus*, bristles of 9th and 10th segments even longer in both sexes. Apical segment of ♀ somewhat more conical.

Measurements; ♀, ♂. Total length of antenna 0·23 mm.; I. joint 0·02 mm. long, 0·023 mm. wide; II. joint 0·032 mm. long, 0·022 mm. wide; III. joint 0·042 mm. long, 0·013 mm. wide; IV. joint 0·041 mm. long, 0·013 mm. wide; V. joint 0·032 mm. long, 0·014 mm. wide; VI. joint 0·045 mm. long, 0·014 mm. wide; VII. joint 0·005 mm. long, 0·007 mm. wide; VIII. joint 0·008 mm. long, 0·005 mm. wide. Head 0·10 mm. long, 0·13 mm. wide. Prothorax 0·12 mm. long, 0·16 mm. wide- Fore femora 0·10 mm. long, 0·045 mm. wide; fore tibiæ (incl. tarsi) 0·14 mm. long. 0·032 mm. wide. Pterothorax ♀ 0·25 long, 0·23 mm. wide; ♂0·20 mm. long, 0·18 mm. wide. Middle femora 0·09 mm. long, 0·03 mm. wide; middle tibiæ (incl. tarsi) 0·14 mm. long, 0·03 mm. wide. Hind femora 0·11 mm. long, 0·035 mm. wide; hind tibiæ (incl. tarsi) 0·20 mm. long, 0·03 mm. wide. Length of wings (without fringe)♀ 0·60 mm., ♂ 0·50 mm. Abdomen ♀ 0·70 mm. long, 0·23 mm. wide; ♂ 0,50 mm. long, 0·15 mm. wide. *Total length* ♀ 1·0—1·3 mm.; ♂ 0·810 mm.

Several specimens of both sexes from Coimbatore, in ears of 'Cumbu' (*Pennisetum typhoideum*), 13th Septr. 1918, Ramakrishna Ayyar coll. No. XIV.

I have pleasure in naming this species in honour of its discoverer.

Near *oligochaetus*, differing especially by more slender and differently coloured antennæ, shorter sense-cones, and in chætotaxy of forewings. From *oligochætus* and all the other species of the *loennbergi*-group, it differs, moreover, by the greater number of bristles on lower vein, a character in which it agrees only with *nubicus*. From this, *ramakrishnai* differs, however, by a longer 5th antennal joint, longer posterolateral bristles of prothorax, and longer wings.

PERISSOTHRIPS PARVICEPS, HOOD.

(Plate XIX, fig. 1).

Coimbatore, on *Ailanthus excelsa*, Ramakrishna Ayyar coll. (many ♀♀, no ♂).—1 ♀ from Coimbatore in shoots of a wild legume, August 1923; Ramakrishna Ayyar

coll. No. 32.—1 ♀ from Coimbatore, in *Caesalpinia pulcherrima* flowers, Sept. 23rd 1923, A. G. Ramaswamiah coll. No. 37.

Bregmatothrips binervis, Kobus.

(Plate XIX, figs. 2, 3).

A few specimens from Palur, S. Arcot, rolling leaf tips of sugar cane, Oct. 29th 1918, Ramakrishna Ayyar coll. No. XXIII.

From Bagnall's description of *B. ramakrishnae* I cannot find any difference between it and the Javanese species. Bagnall has not mentioned the latter, and compares his species in his description with *venustus* and *gracilis*, both American, but not with the Javanese species, living on sugar-cane quite as *ramakrishnae*. Thus, Bagnall may probably have overlooked *binervis*, and I believe therefore that *ramakrishnae* will be a synonym of Kobus's species.

STYLOTHRIPS, N. GEN.

Body without polygonal net-sculpture, of usual shape. Head not produced forwards in front of eyes. Ocelli widely separated, arranged in an acutangular triangle. Occiput with some transverse striæ. Antennae 7-segmented, short and thick, especially the 5th joint extraordinarily short. 3rd and 4th joint with short forked sense-cones. Style one-segmented, cylindrical, bluntly pointed at apex about half as long as the 6th antennal joint. Mouth cone triangularly rounded, not reaching beyond prosternum. Maxillary palpi 3-segmented, joints unusually short: 1st joint wider than long, 2nd slightly longer than wide at base, 3rd cylindrical. Pronotum without long, stout bristles; hind margin with about 20 very short, weak bristle hairs, of which two near either angle and one pair in the middle are longer than the rest. Tibiæ and tarsi unarmed. Wings fully developed in ♀♀, whilst in ♂♂ they are either fully developed or reduced to small pads; forewings with two longitudinal veins, set with some short, very weak bristles. Ovipositor well developed. Penis short and thick. End of abdomen with long, weak bristlehairs, without spines; bluntly rounded in ♂, conically pointed in ♀, never tubiform.

This new genus, in general appearance, structure of wings and by the shape of penis, somewhat resembles the genera *Limothrips* and *Chirothrips*; to the latter by the chætotaxy of pronotum as well. The ocelli are even more widely separated than in those two genera, whilst the shape of head is quite different, and the 7-segmented antennæ offer also an important differential character. Further, *Limothrips* and *Chirothrips* have usually simple sense-cones on antennal segments 3 and 4 (Hinds), although I believe this character is not of generic value, as *L. angulicornis* has forked sense-cones, as may be seen from Jones' figure of an American specimen ("*setariae*")

and from slides of European specimens in my collection. My new genus, on the other hand, has always forked sense-cones.

Thus, *Stylothrips* should come into the vicinity of *Anaphothrips* and *Bregmatothrips*, distinguished from both, however, at once by the one-jointed style and chætotaxy of pronotum. There is only one genus hitherto known with 7-segmented antennæ which does not possess any long, strong posterolateral bristles, *viz.*, *Fulmekiola.* This is, however, also quite different from *Stylothrips*, as the posterolateral bristles of the former, though weak, are much longer than in the latter genus, the short bristle-hairs are much less numerous, whilst the shape of head is produced forward in *Fulmekiola* as in *Chirothrips* and *Limothrips*, thus resembling *Plesiothrips* much more than any other genus. Further, there are no large interocellar bristles in *Stylothrips* as in *Fulmekiola*; the maxillary palpi are of usual shape in *Fulmekiola*, whilst the short, wide basal joint of *Stylothrips* seems to be a very unusual and valuable character.

Stylothrips brevipalpis, n. spec.

(Plate XIX, fig. 4.)

♀. Yellowish brown to dark brown. Tarsi and distal part of tibiæ more or less paler. Antennæ brown, 1st and 2nd joint as dark as the body, 2nd somewhat paler distad; 3rd still paler, 4th darker than 3rd, 5th and 6th still darker, as dark as the body, style somewhat paler, as dark as 4th. Forewings infumated with brownish grey on whole surface, being darker along margins and veins; hind wings slightly infumate along median vein. Bristles of fore wings very weak, hair-like, about half as long as the width of wing in the middle; those along fore margin somewhat

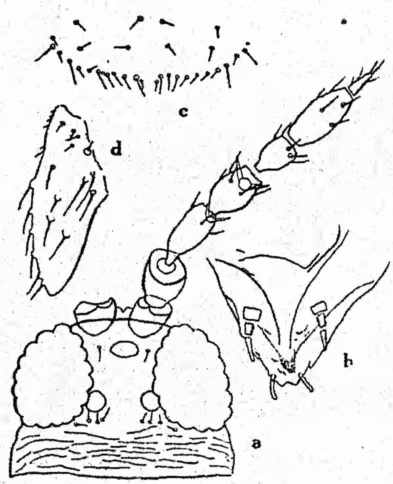

Fig. 10. *Stylothrips brevipalpis*, n. gen., n. sp. *a* dorsal view of head; *b* mouth cone; *c* hind part prothorax, chætotaxy; *d* fore wing of a brachypterous ♂.

longer, in distal part still longer and thinner, so that they are hardly distinguishable from the fringe-hairs.—Chætotaxy : costa 20—25 ; upper vein (4—5+3—4)+3—4 ; lower vein with 7 bristles, regularly disposed, the distances becoming gradually greater distad, the row beginning behind the last ante-medial bristle of chief vein, and ending between the penultimate and last distal bristle of that vein ; scale 4 along fore margin, 1 on surface near base, 1 at apex (and the two hyaline, sense cone-like structures). Tergites 1 to 8 of abdomen with transverse striæ and the hind margin serrate with numerous, small, triangular lobes across the whole width of body.

Measurements, ♀. Total length of antenna 0·17 mm. ; I. joint 0·01 mm. long, 0·02 mm. wide ; II. joint 0·025 mm. long, 0·021 mm. wide ; III. joint 0·03 mm. long, 0·017 mm. wide ; IV. joint 0·026 mm. long, 0·017 mm. wide ; V. joint 0·021 mm. long, 0·014 mm. wide ; VI. joint 0·038 mm. long, 0·017 mm. wide ; VII. joint 0·017 mm. long, 0·005 mm. wide. Head 0·08 mm. long, 0·12 mm. wide. Prothorax 0·13 mm. long, 0·18 mm. wide. Fore femora 0·10 mm. long, 0·05 mm. wide ; fore tibiæ (incl. tarsi) 0·13 mm. long, 0·04 mm. wide. Pterothorax 0·22 mm. long, 0·22 mm. wide. Middle femora 0·08 mm. long, 0·03 mm. wide ; middle tibiæ (incl. tars) 0·10 mm. long, 0·03 mm. wide. Hind femora 0·10 mm. long, 0·04 mm. wide ; hind tibiæ (incl. tarsi) 0·15 mm. long, 0,03 mm. wide. Length of wings (without fringe) 0·53 mm. Abdomen 0·7 mm. long, 0·24 mm. wide. *Total length* 0·8-1·1 mm.

♂ (macropterous). Smaller and paler than ♀, brownish yellow, head darker brown. 1st and 2nd antennal joints not darker than third, the following joints coloured as in ♀. Chætotaxy of wings and structure of abdomen as in ♀.

♂ (brachypterous).—Even paler than the macropterous ♂, pale lemon yellow, head brownish yellow. 1st and 2nd antennal joints pale lemon yellow, the others as in♀. Ocelli arranged as in the macropterous specimens, but somewhat smaller. Pterothorax somewhat shorter and narrower than in the macropterous ♂♂. Wings reduced to small, bristled pads (Fig. 10 d), not quite reaching the hind margin of metathorax. Abdominal structures indistinct because of the very pale, almost transparent colour.

Measurements, ♂ : Total length of antenna 0·14 mm ; I. joint 0·01 mm. long, 0·02 mm. wide ; II. joint 0·023 mm. long, 0.018 mm. wide ; III. joint 0·026 mm. long, 0.014 mm. wide ; IV. joint 0·022 mm. long, 0·014 mm. wide ; V. joint 0·017 mm. long, 0·012 mm. wide ; VI. joint 0·031 mm. long, 0·014 mm. wide; VII. joint 0·012 mm. long, 0·005 mm. wide. Head 0·07mm. long, 0·09 mm. wide. Prothorax 0·10 mm. long, 0·14 mm. wide. Fore femora 0·08 mm. long, 0·04 mm. wide ; fore tibiae (incl. tarsi) 0·11 mm. long, 0·035 mm. wide. Pterothorax 0·16 (macropt.) or 0·14 (brach.) mm. long, 0·17 (macropt.) or 0·15 (brach.) mm. wide. Middle femora 0·06 mm. long, 0·03 mm. wide ; middle tibiae (incl. tarsi) 0·08 mm. long, 0·03 mm. wide. Hind femora 0·08 mm. long, 0·035 mm. wide ; hind tibiae (incl. tarsi) 0·12 mm. long, 0·03 mm. wide. Length of fore wings 0·42

mm. in macropterous, 0·10 mm. in brachypterous ♂♂. Abdomen 0·33 mm. long, 0·17 mm. wide.—*Total length*—0·6—0·8 mm.

Described from several ♀♀, 1 macropterous ♂ and 4 brachypterous ♂♂ from Coimbatore; inside *Chrysanthemum* flowers, 13th August 1918, Ramakrishna Ayyar coll. No. XX.

RAMASWAMIAHIELLA, N. GEN.

Body without polygonal net-sculpture, of usual shape. Head not produced forward in front of eyes. Cheeks not spined nor roughly sculptured. Ocelli closely approximate to one another, arranged in an obtusangular triangle. Antennae 7-segmented, of usual shape; 5th joint fusiform, not unusually short. 3rd and 4th joint with short, forked sense-cones. Style 1-segmented, conical, about one fourth the length of 6th joint. Mouth cone triangular, not or hardly reaching the hind margin of prosternum; maxillary palpi 3-segmented, joints of usual shape and length. Pronotum without long, stout bristles, clothed on whole surface with some short bristle-hairs; hind angles with 2 somewhat stouter bristles which are hardly one fifth as long as the pronotum, between them one short bristlehair; mesad from them, 3 short bristles and one longer pair in the middle of hind margin (Fig. 11c). Tibiae and tarsi unarmed. Wings fully developed in both sexes; fore wings with two longitudinal veins, set with some short bristles. Ovipositor well developed. End of abdomen with some long bristles, without spines; bluntly conical, not tubiform.

Named in honour of its first discoverer, Mr. A. G. Ramiaswamiah.

This new genus should come near *Anaphothrips*, but differs from it by the 7-segmented antennae, so that it somewhat resembles *Fulmekiola* and *Stylothrips*. From the former, it differs, however, by the shape of head, by the shorter style, by the absence of large anteocellar bristles and by the much shorter posterolateral bristles of prothorax. From *Stylothrips*, it differs by the wider head, the different arrangement of ocelli, the shape of antennae, especially joint 5 and style, by the chaetotaxy of pronotum and the longer joints of maxillary palpi.

It is not improbable that my *Thrips microchaetus* might perhaps be placed under the new genus, although in that African species the posterolateral bristles of prothorax are considerably stouter and longer than in the Indian *Ramaswamiahiella*. Because of this character, I would at present prefer to place *microchaetus* as before in the true genus *Thrips*.

RAMASWAMIAHIELLA SUBNUDULA, N. SPEC. (Plate XIX, fig. 5, 6).

♀, ♂. Pale yellow to orange yellow, legs paler. General colour of antennae paler than the head, yellowish white; 2nd and 3rd joints very slightly infumated along both margins, 4th and 5th joint greyish infuscated in distal half or thereabouts,

6th in distal two-thirds; style grey. Ocelli with large red pigment-cups. Eyes black, nearly as long as the cheeks behind them. Pterothorax with sides of each segment arched, mesothorax wider and with more strongly rounded sides than metathorax. Wings almost reaching the 8th abdominal segment in ♀, the end of abdomen or nearly so in ♂, slightly greyish yellow infumation on whole surface. Bristles of forewings half as long as the width of wing near the middle, stouter than in *Stylothrips*; those along costa not longer than the others, even in distal part very well distinguishable from the fringe-hairs, being much thicker and shorter than those. Chætotaxy: costa 25-30; chief vein 7 (4+3 or 3+4)+3; lower vein 10-14 in a continuous row, beginning before the last ante-medial bristle of upper vein and ending between the penultimate and last distal bristle of that vein; scale 4 along fore margin, 1 on surface near base, 1 at apex. Abdominal bristles rather weak and short, hardly one-third as long as the segments themselves, on 7 and 8 in ♀, on 5 to 8 in ♂ half as long, on 9 and 10 about as long as the apical segment; bristles of last segment in ♀ somewhat shorter than those on the penultimate, in ♂ nearly twice as long. Ovipositor extending basad to the middle of 7th segment. Penis short and stout.

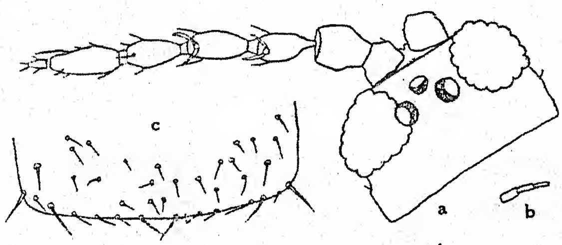

FIG. 11. *Ramaswamiahiella subnudula*, n. gen., n. sp. *a* dorsal view of head; *b* maxillary palpus; *c* hind part of prothorax, chaetotaxy.

Measurements: Total length of antenna 0·18 mm; I. joint 0·015 mm. long, 0·02 mm. wide; II. joint 0·025 mm. long, 0·019 mm. wide; III. joint 0·03 mm. long, 0·013 mm. wide; IV. joint 0·03 mm. long, 0·014 mm. wide; V. joint 0·03 mm. long, 0·013 mm. wide; VI. joint 0·038 mm. long, 0·013 mm. wide; VII. joint 0·01 mm. long 0·005 mm. wide. Head 0·075 mm. long, 0·10 mm. wide. Prothorax 0·09 mm. long, 0·13 mm. wide. Fore femora 0·085 mm. long, 0·04 mm. wide; fore tibiæ (incl. tarsi) 0·12 mm. long, 0·03 mm. wide. Pterothorax 0·165 mm. long, 0·165 mm. wide. Middle femora 0·07 mm. long, 0·025 mm. wide; middle tibiæ (incl. tarsi) 0·10 mm. long, 0·02 mm. wide. Hind femora 0·10 mm. long, 0·035 mm. wide; hind tibiæ (incl. tarsi), 0·15 mm. long, 0·03 mm. wide. Length of wings (without fringe) 0·41 mm. Abdomen ♀ 0·48 mm. long, 0·19 mm. wide; ♂ 0·28 mm. long, 0·13 mm. wide.—*Total length*—♀ 0·75—0,95 mm; ♂ 0·5—0·7 mm.

Described from numerous ♀♀ and ♂♂ from Coimbatore, *viz*:—Numerous specimens in *Calotropis* flowers, Feb. 15th, 1924, Ramakrishna Ayyar coll. No. 39.—A few specimens from the following numbers: No. 3, (T. V. R. No. 46.) *Illecebrum lanatum* flowers, Sept. 11th, 1923, A. G. Ramaswamiah coll.; No. 37, *Cæsalpinia*

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pulcherrim flowers, Sept. 23rd, 1923, A. G. Ramashamiah coll.; No. 38, on Mango flowers, Feb. 15th, 1924, Ramakrishna Ayyar coll.—1♀ from Pomegranate flowers, Sept. 1st, 1923, A. G. Ramaswamiah coll. No. 4. (T. V. R. No. 47.) 2 ♀♀ from *Hibiscus rosa-sinensis* flowers, Sept. 19?3, Ramakrishna Ayyar coll. No. 26.

TUBULIFERA.

Arrhenothrips ramakrishnæ, Hood (Plate XX, fig. 1).

I cannot agree with Bagnall (*Ann. Mag. Nat. Hist.* (9) XIV, p. 635, 1924) in identifying *Arrhenothrips* with *Mesothrips*, because of the sharply pointed mouth-cone in the former (Fig. 12*a*), whilst it is rounded at apex in the latter genus. Further, in *Mesothrips* the wings are more or less constricted in the middle (though sometimes very feebly), in *Arrhenothrips* they are quite parallel-sided throughout.

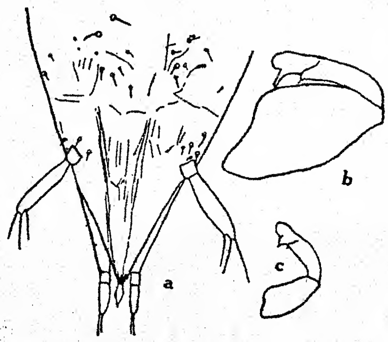

Fig. 12. *Arrhenothrips ramakrishnae* Hood, *a* mouth cone; *b* fore leg of a megalomerous, *c* of a micromerous specimen; *b* and *c* under the same magnification.

As Hood (*Ins. Insc. Menstr.* VII, p. 98, 1919) has already pointed out, it is usually the female which has the larger fore femora. In the ♂, they are more variable in size, from small "micromerous" types to typically "macromerous" ones (fig. 12 *b*, *c*), in quite the same manner as it occurs also in the Australian *Euoplothrips bagnalli*, Hood (Karny, *Proc. Linn. Soc. N. S. W.*, xlix, 3, fig. 3, 1924).

The specimens before me were all taken at Coimbatore from *Mimusops elengi*, partly by Ramakrishna Ayyar, paratypes from material sent to Hood in 1916; and a later lot by A. G. Ramaswamiah, No. 8, Aug. 3rd, 1923. (T. V. R. No. 50.)

Eurhynchothrips ordinarius, (Hood) (Plate XX, fig. 6).

Very closely related to the African type species of the genus, *convergens* Bagnall; if they are really two different species, *ordinarius* may be distinguished by the slightly longer head, different relative lengths of antennal joints, and in the number of duplicated ciliæ, (25 in this *sp.* and 11 to 18 in *convergens*). The accessory bristle near pronotal hind angle, as mentioned in Bagnall's description of the genus, is present,

though it is rather small, in *ordinarius* also (Fig. 13) and was apparently overlooked by Hood.

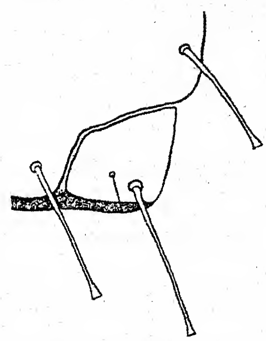

FIG. 13. *Eurhynchothrips ordinarius* (Hood); hind part of prothorax, chætotaxy.

Coimbatore, inside flowers of agathi (*Sesbania grandiflora*), Ramakrishna Ayyar coll. No. XIII (Cotypes from material sent to Hood in 1916).

RHYNCHOTHRIPS PALLIPES, N. SPEC. (Plate XX, fig. 4).

♀. General colour dark brown; extreme tips of all femora and the whole of all tibiæ and tarsi pale yellowish. 1st antennal joint brownish, paler than the body; 2 to 5 bright yellow; 6 yellowish in basal half, dark brownish grey distad; 7 and 8 dark brownish grey throughout. Wings hyaline, with a wide, clouded, smoky cross band in the middle.

Head somewhat longer than wide across eyes, sides smooth, very slightly arched, converging backwards. Eyes black, small, occupying not quite one-third of the length of head, not at all protruding. Ocelli arranged in a rectangular triangle, the anterior one directed forwards, the posterior ones situated in front of a line drawn through middle of eyes. Postocular bristles short, about half as long as the eyes, knobbed at apex.

Antennæ (Fig. 14*a*) of usual shape, seven fourths the length of head. 3rd joint clavate, 4th broadly clavate; 5 to 7 ovate, constricted basad to a short pedicle

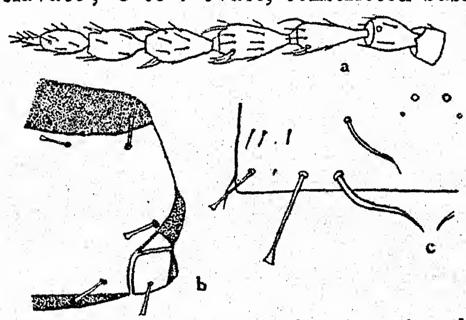

FIG. 14. *Rhynchothrips pallipes*, n. sp. *a* antenna; *b* chætotaxy of prothorax; *c* chætotaxy of abdominal segment.

8 conical, broadly united with 7. Bristles short. Sense-area of 2nd joint close before apex. Sense-cones short, curved, arranged as in *Eurhynchothrips*.

Mouth cone long, sharply pointed, reaching base of prosternum. All prothoracic bristles present (Fig. 14*b*), short and stout, dilated at apex. That on fore coxa of the same length and shape as the posterolaterals. Fore femora rather small, slightly incrassate. Fore tarsi unarmed.

Pterothorax very slightly wider than prothorax, sides slightly arched, somewhat converging backwards. Middle and hind legs short and rather stout.

Wings reaching the base of 5th abdominal segment (abdomen of the unique specimen before me being too expanded longitudinally). Forewing gradually narrowing from base to middle, where it is about two-thirds as wide as near base; not widened again distad, therefore not belonging to the *Haplothrips-Neoheegeria* type. 3 subbasal bristles, about equally distant, similar in length and shape to the posterolaterals of pronotum. Hind margin distad with 9 accessory fringe-hairs.

Abdominal segments (Fig. 14*c*) 1 to 9 with two distad dilated bristles, near each posterior angle, only on 1st segment is the outer one absent. The inner one on each segment is about as long as the tergite itself; laterad from the outer there is a short, pointed bristle-hair. The outer dilated bristle on segments 2 to 4 about half as long as the inner, or a little more, on 5 and 6 two-thirds as long, on 7 to 9 as long as or slightly longer than the inner one. Besides these, the 9th segment is furnished on either side with one sharply pointed, very long bristle, nearly as long as the tube and with a few shorter bristle-hairs, not quite half as long as the 9th segment. Terminal bristles of tube stout basad, hair-like and somewhat curved distad, as long as the tube, alternating with short bristle-hairs, which are about one-third as long as the longer ones. Wing-retaining spines well developed; the hindermost pair on 2nd segment not quite as long as the distance between their tips, on 3 to 5 nearly touching each other at the tips (Fig. 14 c), on 4 and 5 much thicker, but slightly shorter than on 3; on 6 as long as the distance between tips; on 7 very weak, almost hair-like, hardly one-third of the distance between apices. The anterior one everywhere about two-thirds the length of the posterior and also distinctly thinner. Tube short and stout, about two-thirds the length of head, sides parallel at extreme base, beyond that straight and converging.

Measurements, ♀: Total length of antenna 0·35 mm.; I. joint 0·025 mm. long, 0·03 mm. wide; II. joint 0·04 mm, long, 0·028 mm. wide; III. joint 0·06 mm. long, 0·025 mm. wide; IV. joint 0·06 mm. long, 0·03 mm. wide; V. joint 0·057 mm. long, 0·028 mm. wide; VI. joint 0·05 mm. long, 0·025 mm. wide ; VII joint 0·04 mm. long, 0·02 mm. wide; VIII. joint 0·02 mm. long, 0·01 mm. wide. Head 0·20 mm. long, 0·16 mm. wide. Prothorax 0·16 mm. long, 0·31 mm. wide (across fore coxæ). Fore femora 0·20 mm. long, 0·08 mm. wide; fore tibiæ (incl. tarsi) 0·16 mm. long, 0·04 mm. wide. Pterothorax 0·30 mm. long, 0·33 mm. wide. Middle femora 0·13 mm. long, 0·05 mm. wide; middle tibiæ (incl. tarsi) 0·16 mm. long, 0·04 mm. wide. Hind femora 0·18 mm. long, 0·06 mm. wide; hind tibiæ (incl. tarsi) 0·23 mm. long,

0·04 mm. wide. Length of wings (without fringe) 0·7 mm. Abdomen (incl. tube) 1·3 mm. long (too extended), 0·34 mm. wide. Length of tube 0·13 mm., width at base 0·07 mm., at apex 0·033 mm.—*Total length* 2·0 mm.

Described from 1 ♀ taken in Travancore "inside psyllid galls on *Terminalia* leaves" Oct. 1923; Ramakrishna Ayyar coll. No. 33.

This species comes in Priesner's key (*Ent. Zeitschr. Frankf.*, XXXVII, 21:2) near *æthiops* and *ruber*, differing from both at first view by the pale tibiæ of all legs, by colouration of antennæ, and the smoky cross-band of fore wings. It is also quite different from the few species not included in Priesner's table. By the yellow tibiæ, *Rhynchothrips pallipes* reminds one of *Necheegeria citripes*, also from India, differing, however, in the colour of the antennal joints and the fore wings.

Dolichothrips ochripes, n. spec. (Plate XX, fig. 2).

Body very dark castaneous brown, all legs uniformly brownish ochreous, distinctly paler than the body. Antennal joints 1 and 2 paler than body, but darker than legs; 3 to 7 uniformly dark brownish yellow, 7 slightly infumated distad; 8 grey brown. Wings clear.

Head not quite twice as long as wide, sides subparallel. Eyes occupying about two-fifths the length of head. Ocelli approximated to one another, situated near the fore margin. Postocular bristles short, thick, dark brown, inserted somewhat before the middle of head, gradually and slightly dilated distad, about half as long as the eye, laterad not extending beyond the sides of head, visible, therefore, in lateral view only. (Antennæ see Fig. 15*a*.) Mouth cone sharply pointed, much tapering in distal part, with excavate sides, almost reaching the hind margin of prosternum. Maxillary palpi not reaching the tip of mouth cone; basal joint about one and a half times as long as wide, apical joint about seven times as long as wide.

Prothorax long, not very much widened backwards. All bristles present, thick, dark brown, somewhat dilated distad. Posterolaterals about two-fifths the length of prothorax; anterolaterals about half as long or slightly more than the posterolaterals; anteromarginals slightly longer than the anterolaterals. Posteromarginals and mediolaterals about intermediate in length between the posterolaterals and anterolaterals. Anteromarginals about one and a half times as far distant from one another as from the anterolaterals. Mediolaterals inserted in the middle between anterolaterals and posterolaterals. Posteromarginals about three times as far distant from one another as from the posterolaterals. Fore coxal seta about half as long as the posterolateral, otherwise quite similar. Fore legs moderately long, femora not enlarged, tarsi with a very small, inconspicuous tooth.

Pterothorax somewhat longer than wide, sides of either segment slightly arched and converging backwards. Middle and hind legs slender. Wings reaching almost to the sixth abdominal segment, somewhat constricted in the middle. 3 subbasal bristles, about equidistant from another, somewhat shorter than the posterolaterals,

the second slightly longer than 1st and 3rd, all thick, slightly dilated distad, 1st and 2nd dark brown, 3rd paler, yellowish. 6 to 7 interlocated ciliæ very near to the tip of forewing.

Abdomen narrow, gradually tapering to tube. Bristles shaped and coloured as those of prothorax. Segment 1 with one bristle on either side, about as long as the segment. Segments 2 to 8 with two such bristles on either side, on segment 2 the inner somewh.t more than half as long as the segment, the outer about half as long as the inner. Both bristles, the outer more than the inner, increasing in length from segment to segment, but on 8 still shorter than the segment itself ; on 7 both of about equal length, on 8 the outer longer than the inner. 9th segment with 3 bristles on either side, which are about as long as the tube, stout, dark, pointed at apex. Tube short and thick ; terminal bristles weak, pointed, not quite half as long as the tube. Wing-retaining spines very well developed on segments 2 to 6, much less on 7 ; both pairs on all these segments dark and unusually thick. The posterior ones on segment 2 not quite half as long as the distance between their tips, on 3 not quite as long as this distance, on 4 and 5 longer, on 6 half as long, on 7 hardly one-fourth of the distance between tips. Anterior pair everywhere slightly thinner and somewhat shorter than the posterior one, except on segment 7, where both are of about equal length and width. Close before the anterior one, there is an accessory wing-retaining spine on all these segments, somewhat thinner and shorter than the other ; and laterad from them, two short, thick, dark, pointed bristles are inserted (fig. 15*b*.)

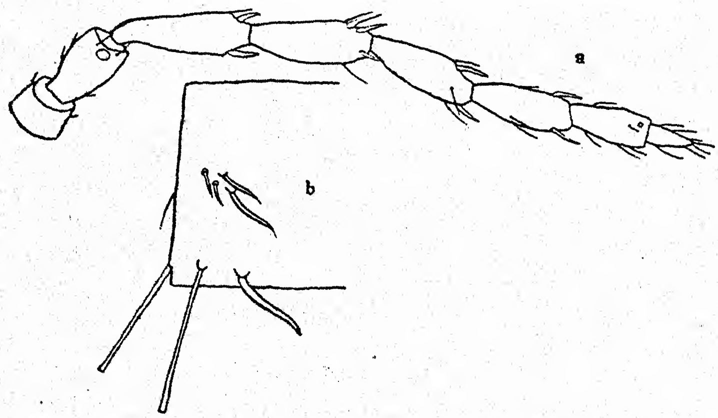

FIG. 15. *Dolichothrips ochripes*, n. sp. *a* antenna ; *b* chaetotaxy of sixth abdominal segment.

Measurements : Total length of antenna 0·37 mm.; I. joint 0·025 mm. long, 0·03 mm. wide ; II. joint 0·04 mm. long, 0·027 mm. wide ; III. joint 0·065 mm. long, 0·022 mm. wide ; IV. joint 0·065 mm. long, 0·023 mm. wide ; V. joint 0·06 mm. long, 0·02 mm. wide ; VI. joint 0·053 mm. long, 0·02 mm. wide ; VII. joint 0·04 mm. long, 0·016 mm. wide ; VIII. joint 0·02 mm. long, 0·01 mm. wide. Head 0·25 mm. long, 0·14 mm. wide. Prothorax 0·16 mm. long, 0·25 mm. wide (across fore coxæ).

Fore femora 0·19 mm. long, 0·06 mm. wide; fore tibiæ (incl. tarsi) 0·25 mm. long, 0·035 mm. wide. Pterothorax 0·30 mm. long, 0·27 mm. wide. Middle femora 0·16 mm. long, 0·05 mm. wide; middle tibiæ (incl. tarsi) 0·24 mm. long, 0·035 mm. wide. Hind femora 0·23 mm. long, 0·05 mm. wide; hind tibiæ (incl. tarsi) 0·30 mm. long, 0·035 mm. wide. Length of wings (without fringe) 0·6 mm. Abdomen (incl. tube) 1·10 mm. long, 0·22 mm. wide. Length of tube 0·13 mm., width at base 0·07, mm., at apex 0·025 mm.—*Total length* 1·6—2·2 mm.

Described from 7 specimens, taken at Coimbatore, in shoots of *Cassia tora*, 4th Aug. 1923; by Ramakrishna Ayyar, No. 28.

Differing from all the hitherto known species of *Dolichothrips* and also from all species of *Neoheegeria* at first view by the uniformly ochreous femora and tibiæ of all legs. Further, the presence of an accessory wing-retaining spine seems to be very remarkable.

NEOHEEGERIA INDICA, HOOD (Plate XX, fig. 5).

When comparing the descriptions of *Neoheegeria indica*, Hood and *Dolichothrips varipes*, Bagnall, one finds the following differences:—length of body of *indica* 1·3 mm.—1·4 mm., of *varipes* 1·8 mm.—2·0 mm; fore tibiæ in apical three-fourths yellow in *indica*, wholly yellow in *varipes*; fore tarsi with a short stout tooth in *indica*, unarmed in *varipes*; head "about 1·2 times as long as wide" in *indica*, "only about 1·6 times as long as broad" in *varipes*.—These characters may perhaps appear to be sufficient for a specific separation; nevertheless, I am convinced after examination of the large material before me that *varipes* is a synonym of *indica*. In this material, there are several specimens without indication of food plant, sent to me by Mr. Ramakrishna Ayyar under the name "*Dolichothrips varipes*, BG.", thus apparently cotypes of Bagnall's species. On the other hand, there are also many specimens from *Ailanthus*, the food plant of *Neoheegeria indica*, Hood. Thus, I have without doubt both "species" before me, but I cannot find any constant difference. As to the length of body, they vary quite in the same manner as *Neoheegeria verbasci*, (Osborn) which is (according to Hinds, p. 189) 1·42 to 2·12 mm. long. The head is always longer than broad, but varying somewhat in relative dimensions, and the proportions given by Hood and by Bagnall respectively seem to be the extreme points of variability, whilst in the material before me the commonest proportion is about 1·3 to 1·4, according to Hood 1·2, according to Bagnall 1·6; these are also represented in the present material but less commonly than the intermediate proportions. The extension of yellow colour on fore tibiæ is also somewhat variable, as described by Hood and by Bagnall respectively. Fore tarsi usually armed with a very small tooth (as figured by Hood), which is sometimes larger, especially in the ♂, sometimes apparently wanting throughout, as described by Bagnall. I must affirm here, therefore, the synonymy indicated above.

In the material before me, there are some anomalous antennæ (fig. 16) of different shape, two of them in one specimen, whilst the others belong to individuals having the other antenna quite normally developed.

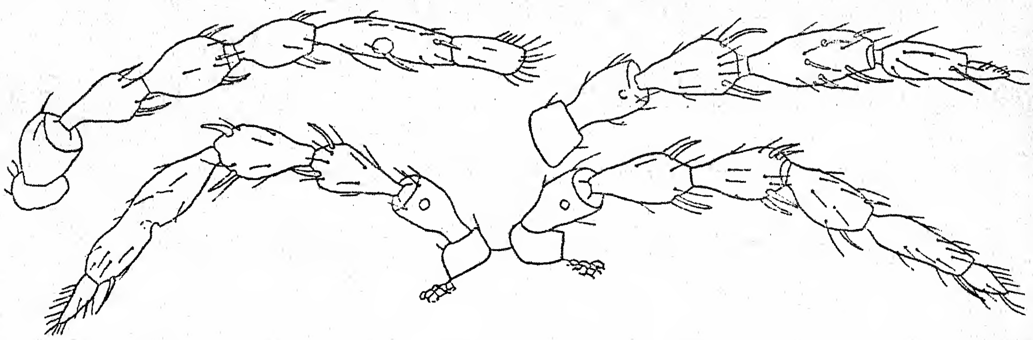

FIG. 16. Anomalous antennae of *Neoheegeria indica* Hood.

Number of duplicated fringe-hairs varying up to about 12.

The specimens before me were all collected by Mr. Ramakrishna Ayyar in the Coimbatore district, *viz.* :—" *Dolichothrips varipes*, BG.," without coll. number and without indication of food plant.—" On *Ailanthus* " without coll. number which are co-types of Hood's *indica.*—In shoots of 'Persian nim,' Sept. 1923, No. 29.—In shoots of *Cassia emarginata*, Sept. 1923, No. 30.

HAPLOTHRIPS SOROR, SCHMUTZ (Plate XX, fig. 3).

Characterized by the shape of antennal joints (Priesner, Treubia, II, 1, p. 6, key and fig. 3, 1921). Body sepia brown, with very rich red pigment. Legs as dark as the body, but without pigment; fore tibiæ and all tarsi yellowish. 1st and 2nd antennal joints as dark as head, following ones yellow, becoming darker from joint to joint, 6th only a little paler than 7 and 8 which are again uniformly sepia brown; every single joint uniformly coloured, not conspicuously paler basad than distad.

1 ♀ from Coimbatore, inside *Chrysanthemum* flowers, 13th Aug. 1918, Ramakrishna Ayyar, coll. No. XX.—2 ♀♀ from Coimbatore, on flowers of *Lantana*, Aug. 3rd, 1923, Y. Ramachandra Rao, coll. No. 1. (T. V. R. No. 44.)

HAPLOTHRIPS INQUILINUS, Priesner.

Resembling in general appearance the genus *Androthrips*, especially *A. ramachandra*, but differing in the structure of fore legs.

Antennal colouration of the specimen now before me: joints 1, 2, 6 to 8 dark throughout; 3 to 5 yellow basad, grey brown infumate distad, 3 paler than 4, and 4 paler than 5 : 3 yellow in basal three-fifths, 4 in basal two-fifths and 5 in basal third.

1 ♀ from Coimbatore, on *Mimusops elengi,* together with *Arrhenothrips ramakrishnæ,* coll. Ramakrishna Ayyar.

HAPLOTHRIPS CEYLONICUS, Schmutz.

General colour blackish brown, with rich red pigment. Antennal joints 1 and 2 of the same colour as the body, 3 to 6 bright lemon yellow, 7 yellow, more or less infumate distad, sometimes infumate throughout, 8 grey brown.—3rd antennal joint very slightly asymmetrical.—One of the specimens before me shows an anomalous antenna (Fig. 17 ; compare with the normal antenna, in *Bull. Deli Proefstation,* No. 23, p. 45, fig. 17 ; 1925).

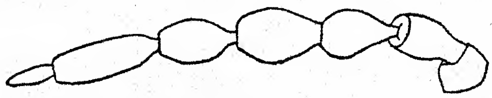

FIG. 17. Anomalous antenna of *Haplothrips ceylonicus* Schmutz.

All the material now before me from Coimbatore, *viz.* :—In flowers on *Lantana*; Aug. 3rd, 1923, Y. Ramachandra Rao coll. No. 1 (T. V. R. No. 44).—In flowers of Jasmine, Sept. 1923 Ramakrishna Ayyar coll. No. 27, 1 ♀.—In Mango flowers, Feb. 15th, 1924, Ramakrishna Ayyar, coll. No. 38.

HAPLOTHRIPS GANGLBAUERI, Schmutz (Plate XXI, fig. 1).

General colour pale brown, with somewhat red pigment, though less than in the preceding species (the specimens studied by Schmutz and by Priesner had no red pigment ; those now before me may represent, therefore, a new variety). Antennal joint 3 pale yellow, 8 pale brown, the others becoming darker gradually from joint to joint, but every single joint not conspicuously paler basad than distad. Third antennal joint strongly asymmetrical (cf. Priesner, Treubia, II, 1, p. 6, key and fig. 1, 1921), much more than in the preceding species. Two of the specimens before me show antennal abnormalities (Fig. 18). One of the specimens before me has no wings, but I am not sure whether it represents an apterous form, or the wings had only fallen off after death.

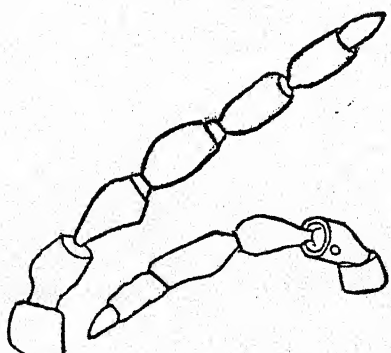

FIG. 18. Anomalous antennae of *Haplothrips ganglbaueri* Schmutz.

Some specimens of both sexes from Coimbatore, on a wild plant, March 1917; Ramakrishna Ayyar, coll. No. XVIII.

HAPLOTHRIPS RAMAKRISHNAI, N. SPEC. (Plate XXI, fig. 2).

♀. General colour pale chestnut brown, apparently without red pigment. Antennæ and legs uniformly grey brown, 3rd joint of antenna scarcely paler than the others; fore tibiæ becoming gradually pale yellowish distad, basal-half of fore tarsi also pale yellowish. Middle and hind tarsi hardly paler than tibiæ. Wings clear (except the dark basal spot).

Head about as long as wide, with subparallel sides. Eyes occupying about two-fifths the length of head, not protruding. Ocelli large, arranged in an almost rectangular triangle, the anterior one situated near the fore margin, the posterior ones close before the middle of eyes. No postocular bristles visible in the unique type specimen. Antennæ (Fig. 19*a*) one and a half times as long as head, 3rd joint very slightly asymmetrical, 4 and 5 broadly rounded. Sense-cones short and thick. Mouth cone (Fig. 19*b*) very small, not quite reaching the middle of prosternum, rounded. Palpi short and thick; basal joint of maxillary palpi wider than long, apical joint about four times as long as wide.

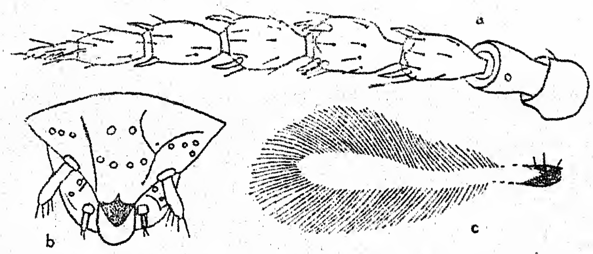

FIG. 19. *Haplothrips ramakrishnai*, n. sp. *a* antenna ; *b* mouth cone ; *c* fore wing.

Prothorax shorter than head, somewhat widened backwards. Posterolateral bristles hyaline, about two-fifths the length of prothorax, truncate at apex. Other bristles not visible with certainty, but apparently present. Fore femora somewhat dilated. Fore tarsi with a very minute tooth, visible under high magnifications only.

Pterothorax as long as wide, sides very slightly arched. Middle and hind legs moderately short and stout. Wing (Fig. 19*c*) strongly constricted near the middle and strongly dilated distad, in the middle hardly half as wide as in distal part. Fringe-hairs dark, not dense, nor duplicated in distal part of fore wings. Subbasal bristles subhyaline, truncated at apex; the middle one somewhat longer than the others, and somewhat more approximated to the third than to the first.

Abdominal bristles hyaline, blunt at apex (even on segment 9), long on the distal segments, short and inconspicuous on the basal ones. Tube two-thirds as long as head, with straight, distally converging sides. Terminal bristles brown, hair-like

distad, shorter than the tube; the shorter ones about one-fourth the length of the others. Wing-retaining spines thick and stout, but not very long; those of hind pair on segment 2 and 7 about one-third as long as the distance between their tips, on segment 3 and 6 half as long, on 4 and 5 two-thirds of the tip-distance.

Measurements, ♀; Total length of antennæ 0.30 mm; I. joint 0·02 mm. long, 0,03 mm. wide; II. joint 0·04 mm. long, 0·027mm. wide; III. joint 0·045 mm. long, 0,028 mm. wide; IV. joint 0·048 mm. long, 0·032 mm. wide; V. joint 0·043 mm. long, 0·028 mm. wide; VI. joint 0·042 mm. long, 0·022 mm. wide; VII. joint 0·04 mm. long, 0·018 mm. wide; VIII. joint 0·027 mm. long, 0·01 mm. wide. Head 0·21 mm. long, 0·19 mm. wide. Prothorax 0·15 mm. long, 0·30 mm. wide(across fore coxæ). Fore femora 0·15 mm. long, 0·08 mm. wide; fore tibiæ (incl. tarsi) 0·18 mm. long, 0·04 mm. wide. Pterothorax 0·35 mm. long, 0·35 mm. wide. Middle femora 0·13 mm. long, 0·05 mm. wide; middle tibiæ (incl. tarsi) 0·20 mm. long, 0·04 mm. wide. Hind femora 0·19 mm. long, 0·055 mm. wide; hind tibiæ (incl. tarsi) 0·26 mm. long, 0·04 mm. wide. Length of wings (without fringe) 0·77, width near the middle 0·035 mm., before apex 0·08 mm. Abdomen (incl. tube) 1·2 mm. long, 0·39 mm. wide. Length of tube 0·14 mm., width at base 0·06 mm., at apex 0·03 mm.—*Total length* 1·9 mm.

1 ♀ from Coimbatore, inside *Chrysanthemum* flowers, 13th Aug., 1918, Ramakrishna Ayyar, coll. No. XX.

Comes between the African *bagnalli* and the Australian *robustus* and *melanoceratus*; according to relative length of antennæ, about intermediate between them. 3rd antennal joint darker than in *bagnalli* and *robustus*, dimensions of antennal joints practically as in *bagnalli* but the middle joints more rounded (compare my figure here with those given by Trybom, 1910). Wings much more broadened distad than in *bagnalli*, tube shorter, more or less as in *robustus*.

AUSTROTHRIPS COCHINCHINENSIS, Karny (Plate XXI, fig. 6).

Comp: Ramchandia Rao, *Agric. Journ. India*, Vol. XIX, pt. IV, pp. 436-437, 1924.

The Indian specimens agree perfectly with the type specimens from Indo-china, but have the 7th antennal segment always more or less greyish infumate, sometimes as dark as the 8th, while this infumation in the Indochinese specimens, though present, is much less conspicuous. One of the specimens before me shows an antennal abnormality (Fig. 20). Several specimens, both sexes, from galls on *Calycopteris floribunda*, Lamk., Taliparamba, May 20th, 1923, Rao Sahib Y. Ramachandra Rao coll; also from same galls-Tenmalai, Travancore, October 1923, Ramakrishna Ayyar coll. No. 34.

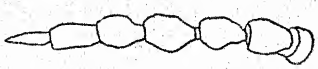

FIG. 20. Anomalous antenna of *Austrothrips cochinchinensis* Karny.

TRICHOTHRIPS HADROCERUS, N. SPEC. (Plate XXI, fig. 3, 4).

Forma macroptera (♀). General colour van Dyke brown, abdomen yellow brown, gradually endarkened distad, segments 8, 9 and tube as dark as pterothorax. Fore tibiæ gradually becoming yellow distad; middle and hind tibiæ not paler than femora or only yellow at extreme tips. All tarsi pale yellow, with a black spot. Antenna segments 1 and 6 to 8 dark grey brown; 2nd yellow brown, 3rd brownish yellow, 4th yellow brown, 5th darker than 4, but paler than 6. Wings clear.

Head a little longer than wide, cheeks parallel. Postocular bristles hyaline, slightly dilated at apex, hardly as long as width of eye. Eyes black, not protruding, occupying not quite one-third of the length of head. Ocelli arranged in a rectangular triangle, well developed, with red pigment-cups. Anterior one situated on a line drawn through the fore margins of eyes, posterior ones on or close behind a line drawn through the centre of the eyes.

Insertion of antennae normal to the genus, 1st joint touching the fore angle of eye. Antennae (Fig. 21 *a*) moderately long and very stout, middle joints almost globular, with a short basal pedicel, third joint more obconical, asymmetrical, viz. outside (posteriorly) more angulated, inside (anteriorly) more rounded. Sense-area of 2nd joint circular, situated either in the middle of joint or only slightly distad from it. Sense-cones hyaline, comparatively long and thick.

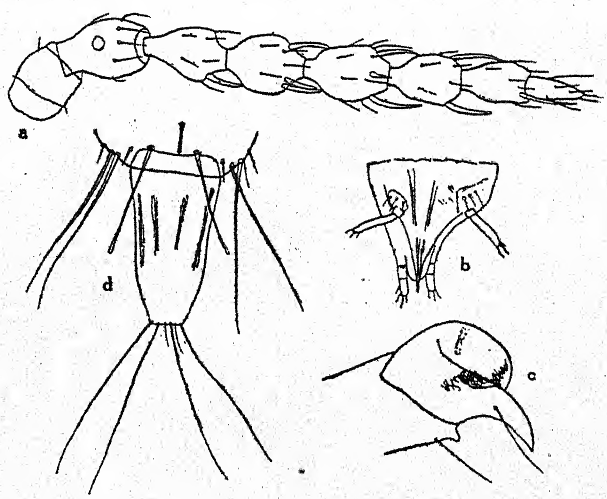

FIG. 21. *Trichothrips hadrocerus*, n. sp., macropterous ♀. *a* antenna; *b* mouth cone; *c* fore tarsus; *d* tube.

Mouth cone (Fig. 21 *b*) hardly extending beyond middle of prosternum, strongly tapering distad, narrowly rounded at apex. The sharply pointed labrum extends beyond the tip of the mouth cone. Palpi moderately long, 2-jointed.

Pronotum almost as long as head, strongly widened backwards. Bristles moderately thick, yellowish hyaline, funnel-shaped at apex. Posterolaterals hardly

one-third of the median length of pronotum; antero-laterals, mediolaterals and posteromarginals somewhat shorter, antero-marginal still shorter. Posteromarginals about three times as far remote from one another as from the posterolaterals. Mediolaterals twice as far distant from anterolaterals as from posterolaterals. Anteromarginals from one another twice as far remote as from anterolaterals. The smooth, chitinized plates of prosternum small, the space between them roughly punctured. Coxal bristle somewhat shorter than the posterolaterals, otherwise similar. Fore femora enlarged. Fore tibiae short and thick, furnished with a small tooth on the inside close to the apex (Fig. 21 *c*). Fore tarsi with a large, pointed, slightly curved tooth.

Pterothorax somewhat wider than long, sides nearly straight, somewhat converging backwards. Middle and hind legs short and thick. Wings hyaline, equally wide throughout, fore pair with 6 to 9 accessory fringe-hairs.

Abdomen almost parallel-sided, not strongly narrowed before the 8th segment. Tube (Fig. 21 *d*) very short and thick, narrowing distad, somewhat abruptly before apex. Lateral bristles hyaline, dilated at apex, the exterior one on 7th segment only slightly so, all others strongly. On 2nd segment the interior bristle somewhat shorter than the segment, the exterior one about half as long. On the following segments the interior one about as long as the segment, the exterior one increasing in length from segment to segment, on 7 both already of about equal length. 9th segment with two long bristles on either side, which are hair-like in distal part and about as long as tube. Mesad from them, there is on either side of ovipositor a shorter, distad dilated bristle. Terminal bristles about as long as tube, hair-like in distal part; the shorter ones scarcely one-fourth as long. Wing-retaining spines moderately thick, but longer than usual. On 2nd segment somewhat aborted: hind pair scarcely half as long as the distance between their tips, much thinner than those on the following segments; fore pair even somewhat shorter and thinner. On segment 3 to 7 the hind pair distinctly longer than the tip-distance, on the middle segments even twice as long, those of fore pair only a little more than half as long as the hindermost.

Forma aptera (♀, ♂).—General colour paler, yellow brown, head somewhat shaded with grey brown, abdominal segments 8, 9 and tube dark brown. Antennal segment 1 brownish yellow, 2 and 3 bright yellow, following ones coloured as in the macropterous form, but somewhat paler.

Eyes somewhat smaller, occupying only a little more than one-fourth of the length of head. Ocelli present, but much smaller than in macropterous specimens. Pterothorax as wide as in the forma macroptera, and only a little shorter than in that form. Wings absent. Wing-retaining spines quite aborted, short and hair-like, even on the middle segments not more than one-third as long as the tip-distance.

Measurements, ♀: Total length of antennae 0·30 mm.; I. joint 0·02 mm. long, 0·03 mm. wide; II. joint 0·05 mm. long, 0·034 mm. wide; III. joint 0·04 mm. long, 0·03 mm. wide; IV. joint 0·04 mm. long, 0·032 mm. wide; V. joint 0·04,

mm. long, 0·03 mm. wide; VI. joint 0·04 mm. long, 0·028 mm. wide; VII, joint 0·037 mm. long, 0·022 mm. wide; VIII. joint 0·03 mm. long, 0·01 mm. wide. Head 0·18 mm. long, 0·17 mm. wide. Prothorax 0·18 mm. long, 0·34 mm. wide (across fore coxae). Fore femora 0·20 mm. long, 0·10 mm. wide; fore tibiae (incl. tarsi) 0·13 mm. long, 0·05 mm. wide. Pterothorax 0·30 mm. long, 0·35 mm. wide. Middle femora 0·11 mm. long, 0·05 mm. wide; middle tibiae (incl. tarsi) 0·13 mm. long, 0·04 mm. wide. Hind femora 0·16 mm. long, 0·06 mm. wide; hind tibiae (incl. tarsi) 0·20 mm. long, 0·04 mm. wide. Length of wings (without fringe) 0·75 mm. Abdomen (incl. tube) 1·05 mm. long, 0·35 mm. wide. Length of tube 0·14 mm., width at base 0·08 mm., at apex 0·03 mm.—*Total length* 1·5—1·8 mm.

♂: Total length of antennae 0·29 mm; I. joint 0·025 mm. long, 0·033 mm. wide; II. joint 0·04 mm. long, 0·03 mm. wide; III. joint 0·038 mm. long, 0·028 mm. wide; IV. joint 0·04 mm. long, 0·03 mm. wide; V. joint 0·04 mm. long, 0·029 mm. wide; VI. joint 0·04 mm. long, 0·027 mm. wide; VII. joint 0·034 mm. long, 0·02 mm. wide; VIII. joint 0·03 mm. long, 0·012 mm. wide. Head 0·20 mm. long, 0·17 mm. wide. Prothorax 0·17 mm. long, 0·36 mm. wide (across fore coxae). Fore femora 0·20 mm. long, 0·10 mm. wide; fore tibiae (incl. tarsi) 0·15 mm. long, 0·05 mm. wide. Pterothorax 0·28 mm. long, 0·34 mm. wide. Middle femora 0·13 mm. long, 0·06 mm. wide; middle tibiæ (incl. tarsi) 0·16 mm. long, 0·04 mm. wide. Hind femora 0·15 mm. long, 0·06 mm. wide; hind tibiæ (incl. tarsi) 0·20 mm. long, 0·04 mm. wide. Abdomen (incl. tube) 0·85 mm. long, 0·33 mm. wide. Length of tube 0·15 mm., width at base 0·09 mm., at apex 0·03 mm.—*Total length* 1·3—1·5 mm.

Described from 8 macropterous and 2 apterous ♀♀ and from 4 apterous ♂♂, taken at Sengleteri, Tinnevelly, on leaves of a wild plant, July 1921, Ramakrishna Ayyar coll. No. VII.

This new species differs widely from all the hitherto known *Trichothrips* species, especially by the unusually thick antennæ. By the structure of fore tibiæ, it should come close to *Plectrothrips*, from which it differs, however, by the quite normal insertion of antennae and the much less developed 8th joint. The shape and structure of the tube, on the other hand, reminds somewhat of the genus *Barythrips*.

Eothrips foliiperda, n. spec. (Plate XXI, fig. 5).

♀, ♂. General colour very dark brown, tube black, paler distad. Fore tibiæ and all tarsi bright lemon yellow. 1st antennal joint as dark as the body, 2nd dark basad, then becoming gradually pale yellow distad; all other joints uniformly pale lemon yellow.

Head somewhat longer than wide, sides subparallel. Eyes not protruding, occupying about one-third of the length of head. Ocelli as in *E. ebneri* (Karny), the anterior one not overhanging, situated behind the fore margin of head between the antennæ. Postocular bristles pointed, hardly half as long as an eye, not extend-

ing beyond the cheeks laterad. Occiput with transverse, confluent striæ. Antennæ (Fig. 22) not quite twice as long as head, slender; 4th joint about three-fourths as long as 3 or 5, and not longer than 8. Joint 6 longer than all others. Mouth cone practically as in *ebneri*, hardly two-thirds as long as prothorax; apical joint of maxillary palpi scarcely four times as long as wide.

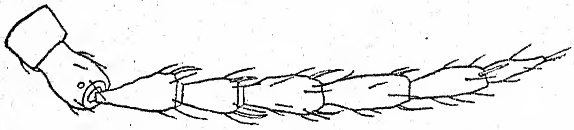

FIG. 22. *Eothrips foliiperda*, n. sp., ♀, antenna.

All prothoracic bristles brown, acutely pointed at apex. Posterolaterals and posteromarginals somewhat longer than the whole prothorax. The others reduced: anterolaterals about one-fifth of the prothoracic length, anteromarginals and mediolaterals still shorter. Posteromarginals about three times as far remote from each other as from the posterolaterals; mediolaterals in the middle between antero- and posterolaterals; anteromarginals about one and a half times as far distant from the anterolaterals as from one another. Prosternum roughly punctured; a smooth plate near either fore margin, a very small one aside of the mouth cone, and a larger, transverse one on either side before hind margin. Fore coxal bristle much reduced. Fore femora not enlarged. Fore tarsi unarmed in both sexes.

Meso and metasternal sutures practically as in *ebneri*. Middle and hind legs moderately long and stout. Wings almost reaching the fifth or sixth abdominal segment; both pairs infumate on whole surface. Subbasal bristles of fore wings brown, pointed at apex, 2nd and 3rd about equal in length, slightly longer than the breadth of wing, 1st somewhat shorter; before each bristle a very short hair. No interlocated ciliæ on hind margin.

All abdominal bristles brown, sharply pointed at apex. The inner one everywhere about as long as the segment itself; the outer one on segment 2 about half as long, then increasing in length distad, and on segment 7 it is somewhat longer than the inner bristle. On eighth segment both distinctly shorter than on the preceding segments. Bristles of ninth segment as long as the tube. Terminal bristles slightly shorter, hair-like distad; the shorter ones hardly one-third as long as the long ones. Sides of tube rather straight, converging distad. Adjacent scales in the ♂ large, very well developed. Wing-retaining spines on segments 3 to 7 dark, stout, distinctly S-curved; hind pair as long or slightly shorter than the distance between their tips. Fore pair not more than half as long as those of hind pair, and also much thinner. On second segment, those of hind pair conspicuously shorter and straight, not S-curved, those of fore pair reduced to very short, inconspicuous bristle-hairs.

Measurements: Total length of antennæ 0·45 mm.; I. joint 0·03 mm. long, 0·05 mm. wide; II. joint 0·055 mm. long, 0·04 mm. wide; III. joint 0·065 mm. long,

0·03 mm. wide; IV. joint 0·05 mm. long, 0·03 mm. wide; V. joint 0·065 mm. long, 0·03 mm. wide; VI. joint 0·07 mm. long, 0·03 mm. wide; VII. joint 0·06 mm. long. 0·022 mm. wide; VIII joint 0·05 mm. long, 0·014 mm. wide. Head 0·24 mm. long, 0·21 mm. wide. Prothorax 0·15 mm. long, 0·39 mm. wide (across fore coxæ). Fore femora 0·18 mm. long, 0·095 mm. wide; fore tibiæ (incl. tarsi) 0·22 mm. long, 0·055 mm. wide. Pterothorax 0·37 mm. long, 0·43 mm. wide. Middle femora 0·16 mm. long, 0·07 mm. wide; middle tibiæ (incl. tarsi) 0·24 mm. long, 0·055 mm. wide. Hind femora 0·25 mm. long, 0·07 mm. wide; hind tibiæ (incl. tarsi) 0·29 mm. long, 0·055 mm. wide. Length of wings (without fringe) 0·9 mm. Abdomen (incl. tube) 1·2 mm. long, 0·42 mm. wide. Length of tube 0·22 mm., width at base 0·10 mm., at apex 0·05 mm.—*Total length* ♀ 1·8—2·2 mm; ♂ 1·5—2·0 mm.

Described from several ♀♀ and ♂♂, taken at Taliparamba, Malabar, on leaves of a wild creeper, 17 Septr. 1918, Ramakrishna Ayyar coll. Nos. III and IV.

Allied to the Javanese *gemmiperda* (Karny) and the African *ebneri* (Karny); the latter one was described originally as *Gynaikothrips*, but should be placed under *Eothrips*. The very long posterolateral and posteromarginal bristles and the unusually short 4th antennal joint distinguish it from both these species. From *gemmiperda*, it differs, moreover, by the better developed wing-retaining spines and by having no bristles directed mesad, in ♂ sex it differs further by the larger adjacent scales of tube; from *ebneri* by the yellow fore tibiæ and the distal antennal segments not being dark.

Androthrips flavipes, Schmutz (Plate XXII, fig. 1).

This species was originally described by Schmutz (*Sitz. Ber. Akad. Wiss. Wien, Math. nat. Kl.*, CXXII, Abt. I, p. 1031, 1913) from *Piper* leaves. Half a year later, Bagnall described under the same name, without having seen Schmutz's paper, a species from specimens got from *Memexylon umbellatum* (*Ann. Mag. Nat. Hist.* (8) XIII, p. 27; 1914). From these two descriptions, only a very few differences between *flavipes*, Schmutz and *flavipes*, Bagnall can be noted. These I have summed up in my *Androthrips*-key (*Zeitschr. wiss. Ins. Biol.*, XI, p. 90; 1915); to these, there should be added also a slight difference in antennal colouration. Nevertheless, I did not propose a new name for *flavipes*, Bagnall, because I thought it very probable that both were synonyms, the differences in the descriptions being based on mere individual characters. In fact, about the same time, Bagnall has stated this synonymy (*Ann. Mag. Nat. Hist.* (8) XV, p. 324; 1915). I am now also of the same opinion, that both belong to the same species. Nevertheless, it is very possible that *flavipes* may have developed on the different food plants into different physiological races. It seems to be so, at least, with the material now before me; but, as there are no specimens from *Piper* or from *Memexylon* in this lot, it is difficult to say anything in this respect on Schmutz's and Bagnall's specimens from the descriptions only. The shape of 4th antennal segment, as figured by Schmutz, somewhat

resembles *Physothrips antennalis* and *antennatus*, and should certainly form a curious, distinctive character; but inaccurate as Schmutz's descriptions and figures always are, it is very doubtful, whether this joint has really such a shape.

In the material before me, I can separate three different races from three different food plants, but the distinguishing characters are certainly too weak to be of specific value. I will, therefore, describe them, without proposing new names for these varieties, and more so, as it is not certain in what relation they will stand to the already described specimens from *Piper* and *Memexylon*.

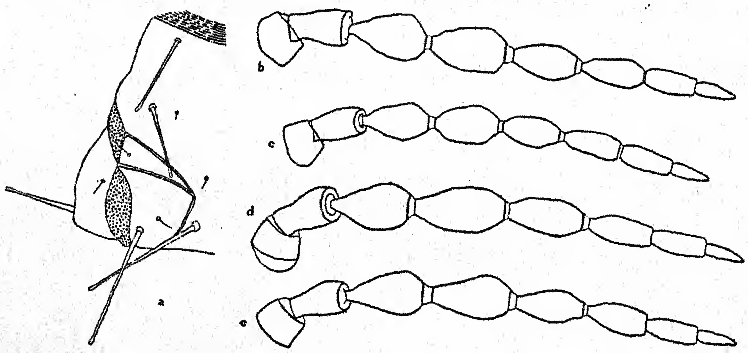

FIG. 23. *Androthrips flavipes*, Schmutz, *a* chaetotaxy of prothorax; *b-e* antennae; *b* from *Mimusops*, *c* from *Terminalia*, *d* and *e* from *Ficus retusa*.

Var. 1. General colour pale brown, immature specimens yellowish, but differing from *ochraceus* by the always darker tube and by the head shaded with greyish; further, the postocular and prothoracic bristles are longer and always knobbed at tip (Fig. 23 *a*), whilst in *ochraceus* they are short and stout, blunt at apex, but not dilated. Antennæ rather slender (Fig. 23 *d* and *e*), third to sixth joint uniformly pale yellowish, seventh shaded with grey distad, 8th pale brownish grey throughout. Fore femora of moderate size, shaded with brown in the basal and outer half. Wings slightly shaded with very pale brownish or yellowish on whole surface. 6 to 12 interlocated fringe-hairs.

30 ♀♀ from "Kollegal, Coimbatore District, damaging the leaves of *Ficus retusa* badly; the leaves do not open; in numbers." August 31st 1918, Ramakrishna Ayyar coll. No. II.

Var. 2. Dark brown. Antennæ (Fig. 23 *b*) perhaps slightly thicker than in the preceding variety; third to sixth joints bright yellow, fourth gradually becoming grey in distal half, 5th and 6th very slightly shaded with greyish distad; 7th and 8th segments wholly dark grey. All legs bright gamboge or cadmium yellow, fore femora larger than in the preceding variety, slightly shaded with brownish towards hind angle. Wings practically clear. 8 to 10 duplicated ciliæ.

3 ♀♀ from Coimbatore, on *Mimusops elengi*, together with numerous *Arrhenothrips ramakrishnae*, Ramkrishna Ayyar coll.

Var. 3. Dark grey brown. Antennæ (Fig. 23 *c*) practically as in the preceding variety, but slightly shorter; third to sixth joints pale greyish yellow, 3rd very slightly shaded with grey at apex, 4th gradually becoming grey in distal half, 5th greyish in distal third, 6th dark grey in distal half, 7th and 8th very dark grey throughout. All legs brownish yellow, fore femora even smaller than in var. 1, gradually becoming dark brown towards hind angle. Wings slightly shaded with greyish yellow. 5 to 6 accessory hairs.

1 ♀ from Travancore, "inside psyllid galls in *Terminalia* leaves," Octr. 1923, Ramkrishna Ayyar coll. No. 33.

ANDROTHRIPS RAMACHANDRAI, N. SPEC. (Plate XXII, fig. 2.)

♀, ♂. General colour blackish brown. Tip of fore femora, whole of fore tibiæ, extreme base of hind tibiæ, apices of middle and hind tibiæ, and all tarsi pale yellow. Antennal joints 1 and 2 as dark as the body; 3 to 6 pale yellowish, 3 slightly shaded with grey before apex, 4 greyish infumate in apical two-thirds, 5 in apical half, 6 dark grey in apical half, 7 and 8 wholly dark grey. Wings clear.

Head one and one-sixth to one and one half times as long as wide, sides very slightly arched, slightly converging backwards. Ocelli large, situated before the middle of eyes. Postocular bristles dark, strong, somewhat shorter than the eyes, slightly knobbed at the tip. (Antennæ Fig. 24). Mouth cone extending to the middle of prosternum, rounded.

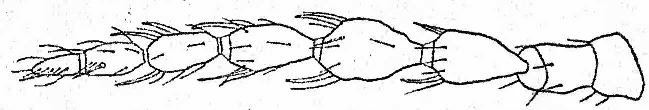

FIG. 24. Antenna of *Androthrips ramachandrai*, n. sp.

Prothoracic and coxal bristles practically as in *flavipes*, long and strong, dilated at apex. Prosternal sculpture also as in *flavipes*. Fore femora enlarged in both sexes, with a strong, cylindrical tooth near base, sometimes with a row of very small tubercles. Fore tibiæ stout. Fore tarsus armed with a conspicuous tooth.

Mesosternal sutures forming a trapezoidal figure wider in front than behind, apposed close to the hind marginal suture of mesosternum; from either fore angle a short, oblique line running forwards and outwards; from the middle of the anterior cross line there is given off a short median long line. Metasternal sutures diverging backwards.

Forewings broad in basal part, distinctly constricted close behind the middle, beyond this very slightly widened again before apex. Subbasal bristles about equidistant, yellowish hyaline, dilated at apex; first about as long as the width of wing at the constriction, second slightly shorter, third about twice as long as second. Number of interlocated fringe-hairs 6 to 10 (usually 8 or 9).

Abdominal segments 2 to 8 near each hind angle with two long, yellowish hyaline bristles, which are slightly dilated at apex; the inner one of basal segments being somewhat shorter than the segments themselves, on 7 slightly longer; the outer one everywhere shorter than the inner. Between these two bristles, there is on every segment a short, stout, dark, pointed bristle. 9th segment with two long, hair-like bristles on either side, which are about as long as the tube, and with some short, pointed bristles. Tube somewhat more than half as long as the head, with distad converging sides. Terminal bristles scarcely shorter than tube, the shorter ones about one-third or one-fourth of the tube-length. Wing-retaining spines strong, dark; those of hind pair very strongly S-curved, on segments 3 to 6 somewhat longer than the distance between their tips, on 7 hardly more than half as long as the tip-distance, on 2 somewhat more than one-third as long; fore pair everywhere shorter and weaker than the hindermost.

Measurements, ♀: Total length of antenna 0·39 mm; I. joint 0·025 mm. long, 0·035 mm. wide; II. joint 0·05 mm. long, 0·035 mm. wide; III. joint 0·065 mm. long 0.035 mm. wide; IV. joint 0·065 mm. long, 0·035 mm. wide; V. joint 0·055 mm. long, 0·027 mm. wide; VI. joint 0·053 mm. long, 0·023 mm. wide; VII. joint 0·047 mm. long, 0·023 mm. wide; VIII. joint 0·033 mm. long, 0·015 mm. wide. Head 0·27 mm. long, 0·18 mm. wide. Prothorax 0·17 mm. long, 0·38 mm. wide (across fore coxae). Fore femora 0,26 mm. long, 0·12 mm. wide; fore tibiæ (incl. tarsi.) 0·23 mm. long, 0·05 mm. wide. Pterothorax 0·35 mm. long, 0·35 mm. wide. Middle femora 0·18 mm. long, 0·06 mm. wide; middle tibiæ (incl. tarsi) 0·24 mm. long, 0·045 mm. wide. Hind femora 0·21 mm. long, 0·07 mm. wide; hind tibiæ (incl. tarsi) 0·26 mm. long, 0·045 mm. wide. Length of wings (without fringe) 0·95 mm. width near base 0·09 mm. in the middle 0·05 mm., before apex 0·06 mm. Abdomen (incl. tube) 1·55 mm. long, 0·39 mm. wide. Length of tube 0·15 mm., width at base 0·07 mm., at apex 0·04 mm.—*Total length* 2·0—2·4 mm.

♂: Total length of antennæ 0·36 mm; I. joint 0·025 mm. long, 0·035 mm. wide; II. joint 0·04 mm. long, 0·03 mm. wide; III. joint 0·06 mm. long, 0·037 mm. wide; IV. joint 0·06 mm. long, 0·035 mm. wide; V. joint 0·05 mm. long, 0·027 mm. wide; VI. joint 0·05 mm. long, 0·02 mm. wide; VII. joint 0·042 mm. long, 0·017 mm. wide; VIII. joint 0·03 mm. long, 0·01 mm. wide. Head 0·20 mm. long, 0·17 mm. wide. Prothorax 0·17 mm. long, 0·35 mm. wide (across fore coxæ). Fore femora 0·23 mm. long, 0·13 mm. wide; fore tibiæ (incl. tarsi) 0·21 mm. long, 0·05 mm. wide. Pterothorax 0·30 mm. long, 0·32 mm. wide. Middle femora 0·16 mm. long, 0·05 mm. wide; middle tibiæ (incl. tarsi) 0·22 mm. long, 0·035 mm. wide. Hind femora 0·19 mm. long, 0·06 mm. wide; hind tibiæ (incl. tarsi) 0·24 mm. long, 0·04 mm. wide. Length of fore wings (without fringe) 0·8 mm., width at base 0·08 mm., near the middle 0·04 mm., before apex 0·055 mm. Abdomen (incl. tube) 1·1 mm. long, 0·29 mm. wide. Length of tube 0·13 mm., width at base 0·06 mm., at apex 0·03 mm.—*Total length* 1·6—2·1 mm.

I have pleasure in naming this new species in honour of its discoverer.

1 ♂ and 1 ♀ from galls on *Calycopteris floribunda*, Lamk., together with numerous *Austrothrips cochinchinensis*, Taliparamba, May 20th, 1923, Rao Sahib Ramachandra Rao coll. Some further specimens of both sexes were received under No. 34. Collected by Ramakrishna Ayyar on same food plant from Tenmalai Travancore; October 1923.

Differing from all hitherto known *Androthrips* species by the dark middle and hind tibiæ; so the specimen recorded in *Journ. Siam. Soc.* XVI, p. 129, from *Melastoma* will apparently not belong to *A. melastomæ*. Very similar in general appearance to *Haplothrips inquilinus*, Priesner, from which it differs at first view by the strong armature of fore femora.

Mesothrips melinocnemis, n. spec. (Plate XXII, fig. 4.)

♀, ♂. General colour dark brown. Apical half of fore femora, the whole of all tibiæ, all tarsi and antennal segments 3 to 8 pale lemon yellow; 8th joint slightly shaded with grey. Fore wings pale brownish infumate on whole surface, with a narrow hyaline cross band at the median constriction. Hind wings infumate especially along margins and median vein.

Head about one and one-third as long as wide. Cheeks slightly protruding behind eyes, beyond that nearly straight, converging backwards, set with some short hairs along whole length and with one very short bristle about the middle, between hind margin of eyes and that of head. Postocular bristles strong, somewhat longer than the eyes, sharply pointed at apex. Posterior ocelli situated close before middle of inner margin of eyes, slightly more distant from each other than from the anterior ocellus, which is directed forwards. (Antennæ Fig. 25.) Mouth cone not actually reaching the middle of prosternum, broadly rounded.

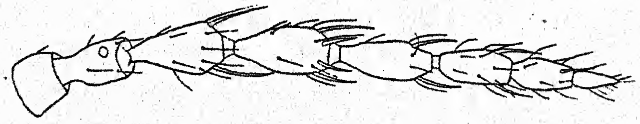

Fig. 25. Antenna of *Mesothrips melinocnemis*, n. sp.

Prothoracic bristles long and strong, acutely pointed at apex; posterolateral slightly shorter than prothorax, posteromarginals somewhat shorter, mediolaterals and anterolaterals not quite half as long as the posterolaterals. Fore femora enlarged, but without tooth inside near base. Fore tarsi with a small, sharply pointed tooth. Prosternal, mesosternal and metasternal structures practically as in the preceding species, but the mesosternal trapezoid structure enclosing a well-defined equilateral triangle.

Wings—except in colour—as in *Androthrips ramachandrai*. Sub-basal bristles darker, pointed at the tips; 2nd one more approximate to 3 than to 1; 1 and 2

slightly longer than the breadth of wing at the constriction, 3 conspicuously shorter. 6 to 9 doubled ciliæ.

Chætotaxy of abdomen practically as in the preceding species, but the bristles of segments 2 to 8 not knobbed and slightly longer. Posterior wing-retaining spines very strongly S-curved, on segments 4 and 5 conspicuously longer than the distance between their tips, on 6 somewhat shorter, on 3 hardly more than half as long as the tip-distance, on 2 and 7 about one-fourth of the distance. Terminal bristles slightly longer than the tube.

Measurements : Total length of antenna 0·38 mm.; I. joint 0·03 mm. long, 0·04 mm. wide ; II. joint 0·05 mm. long, 0·029 mm. wide ; III. joint 0·063 mm. long, 0·034 mm. wide ; IV. joint 0·064 mm. long,0·032 mm. wide ; V. joint 0·055 mm. long 0·026 mm. wide ; VI. joint 0·048 mm. long, 0·023 mm. wide ; VII. joint 0·04 mm. long, 0·02 mm. wide ; VIII. joint 0·033 mm. long, 0·009 mm. wide. Head 0·25 mm. long, 0·19 mm. wide. Prothorax 0·18 mm. long, 0·35 mm. wide (across fore coxæ). Fore femora 0·25 mm. long, 0·14 mm. wide ; fore tibiæ (incl. tarsi) 0·22 mm. long, 0·05 mm. wide. Pterothorax 0·35 mm. long, 0·35 mm. wide. Middle femora 0·16 mm. long, 0·06 mm. wide ; middle tibiæ (incl. tarsi) 0·19 mm. long, 0·045 mm. wide. Hind femora 0·23 mm. long, 0·07 mm. wide ; hind tibiæ (incl. tarsi) 0·28 mm. long, 0·05 mm. wide. Length of fore wings (without fringe) 0·87 mm., width at base 0·075 mm., near middle 0·04 mm., before apex 0·05 mm. Abdomen 1·4 mm. long (incl. tube), 0·38 mm. wide. Length of tube 0·13 mm., width at base 0·06 mm., at apex 0·035 mm.—*Total length* ♀ 2·25 mm., ♂ 2·1 mm.

1 ♂ and 2 ♀♀ from Taliparamba, Malabar, on leaves of a wild creeper, 17 September 1918, Ramakrishna Ayyar coll. Nos. III and IV.

Mesothrips melinocnemis resembles *Androthrips* much more than *Mesothrips*, but differs from the former genus not only by the structure of fore femora, but also by the very long, sharply pointed postocular and prothoracic bristles. By these characters, it comes under *Mesothrips*, where it differs from all the hitherto known species by the colour of *all* tibiæ (from where the name : *melinos*-pale lemon yellow).

Mesothrips apatelus, n. spec. (Plate XXII, fig. 5.)

♀. General colour pale brown, head and middle part of tube, especially along the sides, darker. Tibiæ not paler than the femora, tarsi brownish yellow. Antennal joints 1 and 2 as dark as the body, 3 to 7 pale yellowish, extreme apex of 7 and the whole of 8 shaded with pale brown.

Head cylindrical, about one and a half times as long as wide ; sides straight, not or scarcely converging backwards (Fig. 26 *b*), set with some stout, very short bristles in hind part. Eyes black, not protruding. Ocelli arranged in an almost rectangular triangle, the anterior one directed forwards. Interocellar bristles

very short and weak. Postocular bristles moderately stout and long, not reaching the outer margin of eyes, blunt, but not dilated at apex.

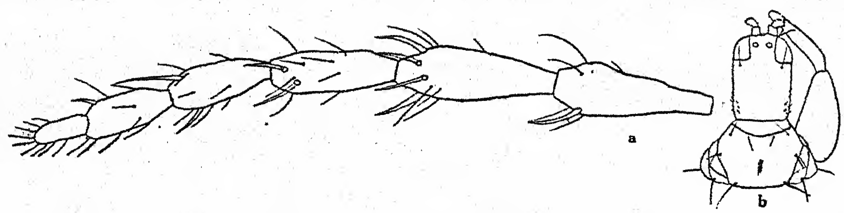

FIG. 26. *Mesothrips apatelus*, ♀. *a* 3rd to 8th antennal segments ; *b* head and prothorax.

Antennæ (Fig. 26 *a*) comparatively slender, middle joints about three times as long as wide. Sense-area of second joint situated close before the apex. Sense-cones moderately long, on 6th joint longer, on 7th shorter than on the others. Formula :—III, 0—1 ; IV, 2—2 ; V, 1—1 ; VI, 1—1 ; VII, —1— (one on dorsum near apex).

Mouth cone reaching the middle of prosternum ; labium broadly rounded ; labrum triangular, with sinuate lateral margins, sharply pointed at apex, not or hardly extending beyond the apical margin of labium. Maxillary and labial palpi cylindrical, with short, annular basal and elongate apical joint ; maxillary ones more than twice as long as the labial palpi, and also distinctly thicker.

Prothoracic bristles stout, moderately long, blunt, but not dilated at apex. Posterolaterals and posteromarginals equal in length, about half as long as prothorax. Mediolaterals somewhat shorter, their insertion very close to the suture behind them. Anterolaterals and anteromarginals still shorter, the former not reaching the point of insertion of the mediolaterals. Arrangement and shape of prosternal plates much as in *Androthrips flavipes*. Coxal bristle short and stout. Fore femora enlarged, without any tooth. Fore tibiæ stout, unarmed. Fore tarsus with a triangular, acute tooth about half as long as the breadth of tarsus.

Pterothorax about as long as wide, with very slightly arched sides, slightly narrowed backwards. Meso-and metasternal sutures in the form of an inverted V ; in the mesosternum this is closed behind by the transverse hind margin and projects forward as a short, straight median suture. Middle and hind legs moderately long and stout. Wings reaching the 6th abdominal segment, practically clear.

Abdominal bristles of hind angles blunt, the inner about as long as the segment, the outer half as long on basal segments, then increasing in length from segment to segment, on 6th segment both equal in length, on 7th the outer longer than the inner ; on 8th the outer somewhat shorter than the segment itself, the inner still somewhat shorter than the outer. Ninth segment on either side with 3 long bristles, hair-like in apical part, as long as the tube, and between them some short, pointed bristles. Tube shorter than head, sides practically straight, converging distad. The long terminal bristles almost as long as the tube, the short ones about one-

fourth of the long ones. Wing-retaining spines on segments 2 to 7 stout, dark, distinctly S-curved. Those of fore pair everywhere a little shorter and thinner than those of hind pair. The latter on segment 2 about one-third as long as the distance between their tips, on 3 somewhat shorter than the tip-distance, on 4 and 5 somewhat longer, on 6 about as long as this distance, on 7 two-thirds of the tip-distance. Between the wing-retaining spines and the lateral margins of abdominal segments there are inserted everywhere about a dozen very short, stout, acutely pointed bristles increasing in number on basal, and decreasing on distal segments.

Measurements, ♀: Total length of antennæ 0·54 mm.; I. joint 0·025 mm. long, 0·04 mm. wide; II. joint 0·05 mm. long, 0·035 mm. wide; III. joint 0·10 mm. long, 0·035 mm. wide; IV. joint 0·105 mm. long, 0·033 mm. wide; V. joint. 0·09 mm long, 0·027 mm. wide; VI. joint 0·07 mm. long, 0·28 mm. wide; VII joint 0·063 mm. long, 0·026 mm. wide; VIII. joint 0·038 mm. long, 0·012 mm. wide. Head 0·34 mm. long, 0·22 mm. wide. Prothorax 0·23 mm. long, 0·46 mm. wide (across fore coxæ). Fore femora 0·33 mm. long, 0·17 mm. wide; fore tibiæ (incl. tarsi) 0·30 mm. long, 0·08 mm. wide. Pterothorax 0·50 mm. long, 0·52 mm. wide. Middle femora 0·27 mm. long, 0·09 mm. wide; middle tibiæ (incl. tarsi) 0·38 mm. long, 0·06 mm. wide. Hind femora 0·35 mm. long, 0·09 mm. wide; hind tibiæ (incl. tarsi) 0·46 mm. long, 0·06 mm. wide. Length of wings (without fringe) 1·25 mm. Abdomen (incl. tube) 1·9 mm. long, 0·45 mm. wide. Length of tube 0·29 mm., width at base 0·10 mm., at apex 0·05 mm.—*Total length* 2·6—3·2 mm.

Described from two females taken at Kollegal, Coimbatore, together with numerous specimens of *Androthrips flavipes*, *Gynaikothrips uzeli* and *Gigantothrips elegans* "damaging the leaves of *Ficus retusa* badly; the leaves do not open", Ramakrishna Ayyar coll. No. II, Aug. 31st 1918.

This new species resembles very closely *Mesothrips jordani*, Zimmermann which occurs on the same food plant in Java, but differs from it by the much slenderer antennæ and by shape of head which is practically parallel-sided in *apatelus*, whereas it is conspicuously narrowed backwards in *jordani*. *Mesothrips apatelus* comes very much nearer to *Androthips flavipes*, of which numerous specimens were taken together with the two specimens of *apatelus* ♀♀, but the latter differs from this *Androthrips* by the absence of fore femoral tooth, by the prothoracic bristles not being dilated apically, by the mediolaterals inserted very close to the suture, and by the tips of anterolaterals not reaching the insertion of mediolaterals. In *Androthrips flavipes* (fig. 23*a*), on the other hand, the prothoracic bristles are dilated at tips, the mediolaterals are fully half as far removed from the suture as from the anterolaterals, and these latter clearly extend beyond the insertion-point of mediolaterals.

MESOTHRIPS SPEC. INDETERM.

In the material before me, there is also one ♂ of a *Mesothrips* from Coimbatore, taken in leaf rolls on Mango by C. K. Subramaniam, T. V. R. No. 43, March 1924.

Unfortunately, the specimen is too damaged for determination or description, having no antennæ (except joints 1 and 2) nor middle and hind legs. Nevertheless, I will shortly characterize it, because it would be of interest, if one of the ardent Indian Entomologists would succeed in rediscovering this species with more numerous and less mutilated specimens.

General colour black, fore tibiæ brownish yellow, shaded with dark brown along both margins. Head longer than wide, sides very finely granulated. Fore femora greatly enlarged. Fore tarsus with a large, stout tooth. Tube about three-fourths as long as head, sides converging distad. Length of body 2·5 mm.

RAMAKRISHNAIELLA, N. GEN.

Head distinctly longer than prothorax, about one and one-fourth times as long as broad, not swollen behind; sides very slightly arched and somewhat converging backwards, very finely granulated, with a single dark, stout, acutely pointed bristle in posterior part. Eyes moderately large, not protruding. Anterior ocellus situated behind the insertion of antennæ, not on a prominent hump, and directed forwards. In the vicinity of ocelli no conspicuous bristles. Postoculars short and weak. Antennæ 8-jointed, 7th joint very well separated from the sixth. Mouth cone broadly rounded. All legs short and stout, especially the fore femora thickened, but not greatly enlarged, not curved, inner margin not angulately excavate, without any tooth. Fore tibiæ unarmed; fore tarsus practically unarmed. Wings not constricted in the middle. 8th abdominal segment (Fig. 27 *c*, *d*) on either margin before the middle with a blunt tubercle, somewhat resembling *Kakothrips*, more distinct in the ♂ than in the ♀.

I have allowed myself the pleasure of naming this interesting new genus in honour of its discoverer, the merited Indian Entomologist Mr. Ramakrishna Ayyar.

This genus very closely resembles in many respects the genus *Gynaikothrips*, but may be distinguished from it at once by the presence of a stout genal bristle and by the structure of the 8th abdominal segment.

RAMAKRISNAIELLA UNISPINA, N. SPEC.

(Plate XXII, fig. 6.)

♀, ♂. General colour black, fore tibiæ yellowish brown, shaded with black along both sides. 2nd antennal joint paler distad, 3 to 6 uniformly dark yellow, 7 and 8 uniformly blackish. Wings with greyish yellow infumation over whole surface.

Head (Fig. 27*b*) about one and one-fourth times as long as wide, otherwise as described for the genus. Ocelli situated before the middle of eyes. Antennæ stout with rather thick joints (Fig. 27*a*). Sense area of second joint situated close before

the apex. Sense-cones on 3 and 4 thick and moderately long, on 5 and 6 very long and slender. Formula :—III, 0—1 ; IV, 1—2^{+1} ; V, 1—1 ; VI, 1—1 ; VII, —1— (one on dorsum near apex).

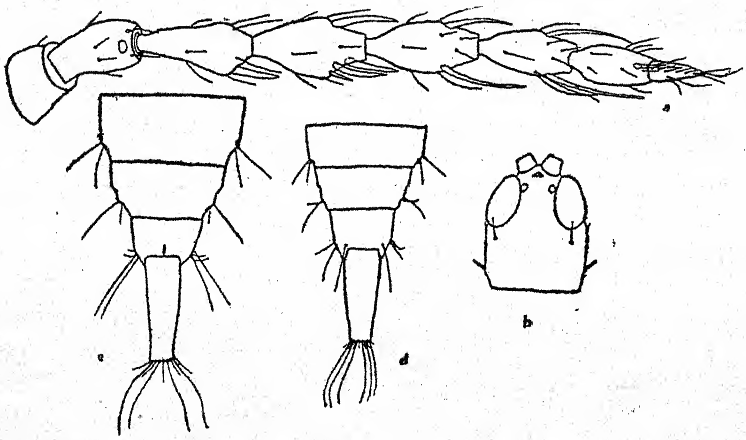

FIG. 27. *Ramakrishnaiella unispina*, n. gen., n. sp. *a* antenna ; *b* head ; *c* and *d* end of abdomen ; *c* ♀, *d* ♂.

Prothoracic and coxal bristles moderately stout and not very long, blunt at apex. Fore legs as described for the genus ; fore tarsus unarmed in ♀, in ♂ with a small and very blunt tooth which is wider at base than long. Sides of pterothorax arched, tapering backwards. Wings reaching almost to the 6th abdominal segment, equally wide throughout, fore pair with 14 or 15 duplicated ciliæ.

Abdominal bristles pale, blunt at apex, on basal segments the inner ones longer than the outer ones, the latter increasing in length from segment to segment, on 7 and 8 they are longer than the inner ones. Bristles of 9th segment pointed, rather hair-like in distal part, conspicuously shorter than the tube. Terminal bristles of the same shape, the longer ones shorter than the tube, the shorter ones about two-fifths of the longer ones. Tube as long as width of the head. Wing-retaining spines strongly S-curved, the fore pair everywhere much shorter and thinner than the hind pair. The latter on segment 2 about one-third as long as the distance between their tips, on 3 to 5 about as long as the tip-distance or somewhat shorter, on 6 and 7 not visible because of the dark colour of these segments.

Measurements, ♀, ♂ : Total length of antennæ 0·44 mm. ; I. joint 0·03 mm. long, 0·038 mm. wide ; II. joint 0·05 mm. long, 0·032 mm. wide ; III. joint 0·07 mm, long, 0·033 mm. wide ; IV. joint 0·073 mm. long, 0·038 mm. wide ; V. joint 0·068 mm. long, 0·032 mm. wide ; VI. joint 0·06 mm. long, 0·029 mm. wide ; VII. joint 0·053 mm. long, 0·024 mm. wide ; VIII. joint 0·038 mm. long, 0·013 mm. wide. Head 0·26 mm. long, 0·21 mm. wide. Prothorax 0·17 mm. long, 0·35 mm.

wide (across fore coxæ). Fore femora 0·20 mm. long, 0·11 mm. wide; fore tibiæ (incl. tarsi) 0·19 mm. long. 0·055 mm. wide. Pterothorax 0·33 mm. long, 0·36 mm. wide. Middle femora 0·14 mm. long, 0·05 mm. wide; middle tibiæ (incl. tarsi) 0·20 mm. long, 0·045 mm. wide. Hind femora 0·21 mm. long, 0·075 mm. wide; hind tibiæ (incl. tarsi) 0·32 mm. long, 0·05 mm, wide. Length of wings (without fringe) 0·85 mm. Abdomen (incl. tube) 1,3 mm. long, 0·37 mm. wide. Length of tube 0·20 mm., width at base 0·075 mm., at apex 0·043 mm.—*Total length* ♀ 2·0—2·5 mm.; ♂ 1·8-2·0 mm.

Described from 4 ♀♀ and 3 ♂♂ taken at Taliparamba, Malabar, on leaves of a wild plant, 16th September 1918, Ramakrishna Ayyar coll No. VIII.

Easily distinguishable by the generic characters.

Gynaikothrips uzeli, Zimmermann.

(Plate XXII, fig. 3 and Plate XXIII, fig. 1.)

A series of specimens of this very common and widely spread species from Kollegal, Coimbatore, "damaging the leaves of *Ficus retusa* badly; the leaves do not open; in numbers," together with numerous *Androthips flavipes*, some *Gigantothrips elegans*, and two ♀♀ of *Mesothrips apatelus*, Aug. 31st 1918, Ramakrishna Ayyar coll. No. II.

2 of the ♀♀ now before me have a distinct fore tarsal tooth, whilst one of the ♂♂ has the tube distinctly shorter than head. Otherwise, these specimens do not differ in any respect from the typical ones with which they were collected.

Gynaikothrips chavicæ (Zimmermann).

1 mutilated ♀, taken together with some *Gynaikothrips pallipes* from Wynad, on pepper leaf, November 1918; Ramakrishna Ayyar coll. No. 31.

KEY TO THE SPECIES OF *GYNAIKOTHRIPS* WITH YELLOW MIDDLE AND HIND TIBIÆ.

1. Antennæ about twice as long as head, uniformly grey brown, or joints 3 to 6 pale basad only. 3 to 7 duplicated ciliæ . . . . 2.

   Antennal joints 3 to 6 quite yellow . . . 3.

2. Fore wings greyish infumate, slightly constricted close behind the middle. Antennæ uniformly grey brown. Head one and one-fourth times as long as wide. Tube 0·66 to 0·75 times as long as head. Length of body 1·6—1·8 mm. In leaf galls on *Dipterocarpus crinitus* . . . . . . comp. *Cryptothrips pusillus*, Karny.

Fore wings not narrowed in the middle, slightly yellowish, with a well defined median vein. Antennal joints 3 to 6 pale basad. Head one and one-third times as long as wide. Tube 0·6 as long as head. Length of body 1·3—2·0 mm. In leaf galls on *Ficus punctata* . . . . . . *Gynaikothrips longicornis*, Karny.

3. Prothoracic bristles sharply pointed . . . . 4.

Prothoracic bristles blunt or slightly dilated at the tips . . . . 6.

4. Antenal joint 8 and tip of 7 slightly darker than the preceding ones. Head more than one and a half times (1·52 to 1·61) as long as wide. Wings smoky especially along margins and median vein; about 12 duplicated ciliæ. Tube 0·66 to 0·72 as long as head. Length of body 2·1—2·9 mm. In leaf galls on *Vitis lanceolaria* . . . . . . *Gynaikothrips pallicrus*, Karny.

Antennal joints 3 to 8 uniformly yellow. Head less than one and a half times as long as wide . . 5.

5. Head about 1·42 times as long as broad. Wings reaching eighth abdominal segment, ciliæ smoky. Tube 0·6 as long as head. Length of body 1·9 mm. In leaf galls on *Piper nigrum* . . . . . *Gynaikothrips karnyi*, Bagnall.

Head about 1·3 times as long as broad. Wings reaching sixth abdominal segment, yellowish, with indistinct darker long stripe; 12 duplicated ciliæ. Tube 0·8 as long as head. Length of body 2·2 mm. In leaf galls on *Pavetha hispida* (sec. Schmutz also on *Piper*; but these, I believe, will not belong to the same species) . . . . . . *Gynaikothrips mirabilis*, Schmutz.

6. Head twice as long as wide. Middle joints of antennæ about 4 times as long as wide; apical part of 7 and the whole of 8 brownish. Wings clear, 12 to 20 duplicated ciliæ. Tube 0·65 as long as head. Length of body 3—3·7 mm. In leaf galls on *Planchonia valida* . . . . *Gynaikothrips gracilis*, Karny.

Head about one and one-third to one and two-thirds as long as wide . . . . 7.

7. Wings clear or very slightly yellowish . . . . 8.

Wings brownish infumate, especially along median vein. Tube about 0·8 as long as head . . . 10.

8. Middle antennal joints about 3 times as long as wide, 3 to 7 bright yellow, 7 sometimes infumate at extreme tip, 8 grey brown. Head 1·37 to 1·48 times as long as wide. 14 or 15 duplicated ciliæ. Tube 0·68 as long as head. Length of body 1·8—2·5 mm. In leaf galls on *Terminalia* . . . . . *Gynaikothrips interlocatus*, n. sp.

7th antennal joint greyish in apical half or third. Head 1·5 to 1·58 times as long as wide. 6 to 9 duplicated ciliæ. Tube 0·65 to 0·67 as long as head . . . . 9.

9. Middle antennal joints about 3 times as long as wide. Length of body 1·6—2·2 mm. In leaf galls on *Dipterocarpus alatus* . . . . *Gynaikothrips siamensis*, Karny.

Middle antennal joints about 4 times as long as wide. Length of body 2—2·5 mm. In leaf galls on *Eugenia spec.* . . . . *Gynaikothrips daetymon*, Karny.

10. Antennæ 8-jointed. Middle antennal segments about twice as long as wide; 3 to 6 yellow, 7 and 8 quite dark brown. Head 1·3 to 1·4 times as long as wide. 7 to 10 duplicated ciliæ. Length of body 1·9—2·5 mm. In leaf galls on *Piper* . . . *Gynaikothrip pallipes*, Karny.

Of the following species only one antenna hitherto known, this being 7-jointed. Middle antennal segments about 4 to 5 times as long as wide; all joints, except 1 and 2, quite yellow. Head one and a half times as long as wide. 2 to 3 duplicated ciliæ. Length of body 2·2 mm. In leaf galls on *Ficus spec.* . . . . *Gynaikothrips inquilinus*, Karny.

Gynaikothrips interlocatus, n. spec.

(Plate XXIII, fig. 6.)

♀, ♂. General colour black, all tibiæ and tarsi uniformly bright yellow. Second antennal joint becoming paler distad, 3 to 7 uniformly dark yellow, the 7th sometimes slightly shaded with greyish at extreme tip, 8 uniformly brownish grey. Wings clear, transparent.

Head two-fifths or one-half longer than wide; cheecks sub-parallel, very slightly arched and somewhat converging backwards, very finely granulated (visible under high magnifications only), set with some very short, weak hairs. Eyes relatively small, occupying somewhat more than one-third of the head-length, not protruding. Postocular bristles black, thick, short, not reaching the hind margin of eyes, and hardly dilated at apex. (Antennæ Fig. 28.)

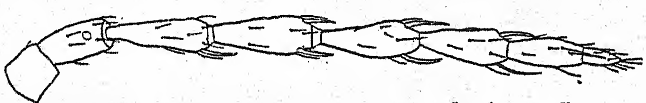

Fig. 28. Antenna of *Gynaikothrips interlocatus*, n. sp.

Prothoracic bristles shaped as postoculars; posteromarginals and posterolaterals of same length, hardly half as long as prothorax; the others shorter. Fore legs moderately stout and long, femora not enlarged, tarsi unarmed. Pterothorax as long as wide, somewhat narrowing backwards, with slightly arched sides. Wings not constricted in the middle; subbasal bristles thick and dark, very slightly dilated at apex, equidistant, not quite as long as the breadth of wing, the middle one slightly shorter than the others. 14 to 15 interlocated ciliæ.

Abdominal bristles dark, stout, blunt or very slightly dilated at apex; the inner one everywhere about as long as the segments themselves, the outer one about half as long on basal segments, gradually increasing in length distad, on 7 and 8 they are longer than the inner one. Bristles of 9th segment stout basad, hair-like distad, not quite as long as tube. The tube about as long as the width of head; sides converging, distad slightly more than basad. Terminal bristles shaped as those of 9th

segment, the longer ones shorter than tube, the shorter ones about two-fifths as long as the long ones. Wing-retaining spines thick, S-curved, fore pair much shorter and thinner than hind pair. The latter on segment 2 not quite half as long as the distance between their tips, on 3 slightly shorter than the tip-distance, on 4 to 6 somewhat longer than this distance, on 7 weak and hair-like, somewhat shorter than on the preceding segments.

Measurements, ♀: Total length of antenna 0·49 mm.; I. joint 0·03 mm. long, 0·04 mm. wide; II. joint 0·055 mm. long, 0·032 mm. wide; III. joint 0·085 mm. long, 0·028 mm. wide; IV. joint 0·08 mm. long, 0·033 mm. wide; V. joint 0·075mm. long, 0·03 mm. wide; VI. joint 0·075 mm. long, 0·03 mm. wide; VII. joint 0·06 mm. long 0·023 mm. wide; VIII. joint 0·03 mm. long, 0·01 mm. wide-Head 0·31 mm, long, 0·21 mm. wide. Prothorax 0·20 mm. long, 0·39 mm. wide (across fore coxæ). Fore femora 0·24 mm. long, 0·09 mm. wide; fore tibiæ (incl. tarsi) 0·28 mm. long, 0·05 mm. wide. Pterothorax 0·40 mm.. long, 0·40 mm. wide. Middle femora 0·20 mm. long, 0·065 mm. wide; middle tibiæ (incl. tarsi) 0·27 mm. long, 0·04 mm. wide. Hind femora 0·29 mm. long, 0·075 mm. wide; hind tibiæ (incl. tarsi) 0·37 mm. long, 0·045 mm. wide. Length of wings (without fringe) 0·8 mm. Abdomen (incl. tube) 1·5 mm. long, 0·42 mm. wide. Length of tube 0·21 mm., width at base 0·08 mm., at apex 0·04 mm.—*Total length* 2·4 mm.

♂: Total length of antennæ 0·405 mm.; I. joint 0·025 mm. long, 0·035 mm. wide; II. joint 0·045 mm. long, 0·027 mm. wide; III. joint 0·075 mm. long, 0·023 mm. wide; IV. joint 0·07 mm. long, 0·03 mm. wide; V. joint 0·065 mm. long, 0·027 mm. wide; VI. joint 0·055 mm. long, 0·024 mm. wide; VII. joint 0·045 mm. long, 0·02 mm. wide; VIII. joint 0·025 mm. long, 0·01 mm. wide. Head 0·26 mm. long, 0·19 mm. wide. Prothorax 0·15 mm. long, 0·31 mm. wide (across fore coxæ). Fore femora 0·21 mm. long, 0·09 mm. wide; fore tibiæ (incl. tarsi) 0·26 mm. long, 0·04 mm. wide. Pterothorax 0·32 mm. long, 0·33 mm. wide. Middle femora 0·20 mm. long, 0,06 mm. wide; middle tibiæ (incl. tarsi) 0·23 mm. long, 0·04 mm. wide. Hind femora 0·24 mm. long, 0·07 mm. wide; hind tibiæ (incl. tarsi) 0·31 mm. long, 0·04 mm. wide. Length of wings (without fringe) 0·75 mm. Abdomen (incl. tube) 1·1 mm. long, 0·30 mm. wide. Length of tube 0·18 mm., width at base 0·075 mm., at apex 0·035 mm.—*Total length* 1·8 mm.

Described from 2 ♀♀ and 1 ♂ taken in Travancore, "inside psyllid galls in *Terminalia* leaves," October 1923, Ramakrishna Ayyar coll. No. 33.

This species may be distinguished from the hitherto known *Gynaikothrips* species with quite yellow middle and hind tibiæ by the key given above.

Gynaikothrips pallipes, Karny.

Some damaged specimens (all having the antennæ broken off at base of 3rd joint), from Wynad in tender leaf rolls of pepper, together with one specimen of *Gynaikothrips chavicae*, November 1918; Ramakrishna Ayyar coll. No. 31.

Dinothrips sumatrensis, Bagnall.

(Plate XXIII, figs. 2, 3.)

Some ♀♀ from Taliparamba, Malabar, under the bark of a wooden post in a shed, September 1918, Ramakrishna Ayyar coll. No. XVII.

One of the specimens has one antenna anomalous, whilst the other is quite normal (Plate VIII, fig. 4).

Mouth cone rather pointed somewhat reminding *Liothrips-Ethirothrips.*

Gigantothrips tibialis, Bagnall.

(Plate XXIII, fig. 4.)

Several specimens from leaves of *Careya arborea*, Taliparamba, Malabar, Sept. 30th 1923, Y. Ramachandra Rao coll. T. V. R. No. 36; originally described from Ceylon, from the same food plant.

Gigantothrips elegans, Zimmermann.

(Plate XXIII, fig. 5.)

Some specimens from Perur, Coimbatore, on leaves of *Ficus retusa*, April 1922 Ramakrishna Ayyar coll. No. I.; and from Kollegal, Coimbatore, "damaging the leaves of *Ficus retusa* badly; the leaves do not open; in numbers;" Aug. 31st 1918, Ramakrishna Ayyar coll. No. II.

The specimens now before me are somewhat paler than the typical ones from Java, and have the middle tibiæ only slightly brownish at base or—even quite yellow; differs, nevertheless, from the preceding species not only by the hind tibiæ being always dark brown basally but also by some slight, but apparently constant differences in shape of head and antennal structure.

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PLATE XVI.

FIG. 1. Hydatothrips ramaswamiahi, n. sp., larva.

FIG. 2. Hydatothrips ramaswamiahi, n. sp., ♂.

FIG. 3. Hydatothrips ramaswamiahi, n. sp., ♀.

FIG. 4. Tryphactothrips mundus, n. sp., ♀.

FIG. 5. Heliothrips indicus, Bagnall, ♀.

FIG. 6. Rhipiphorothrips cruentatus, Hood, ♀ with anomalous, asymmetrical head.

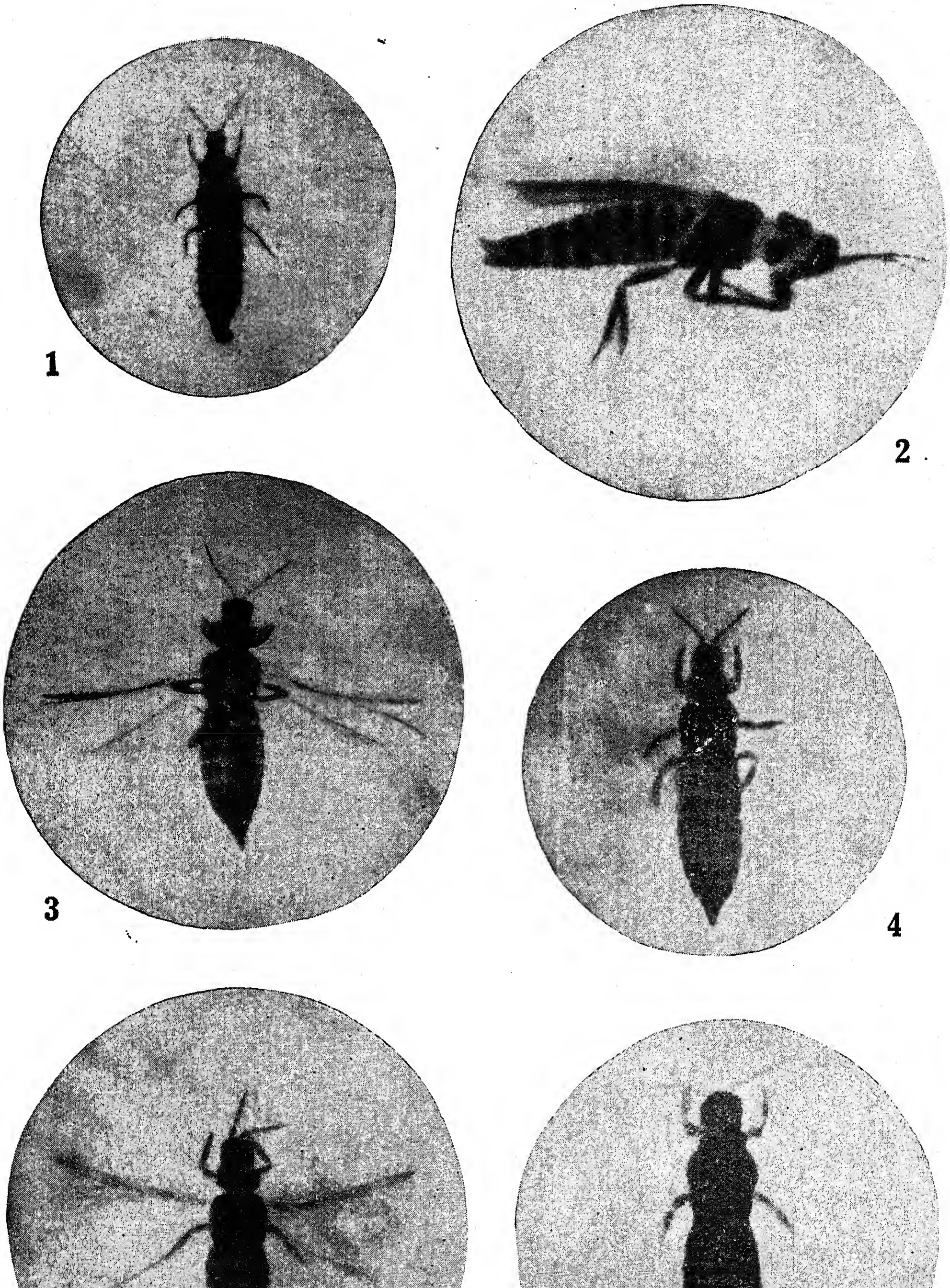
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PLATE XVII.

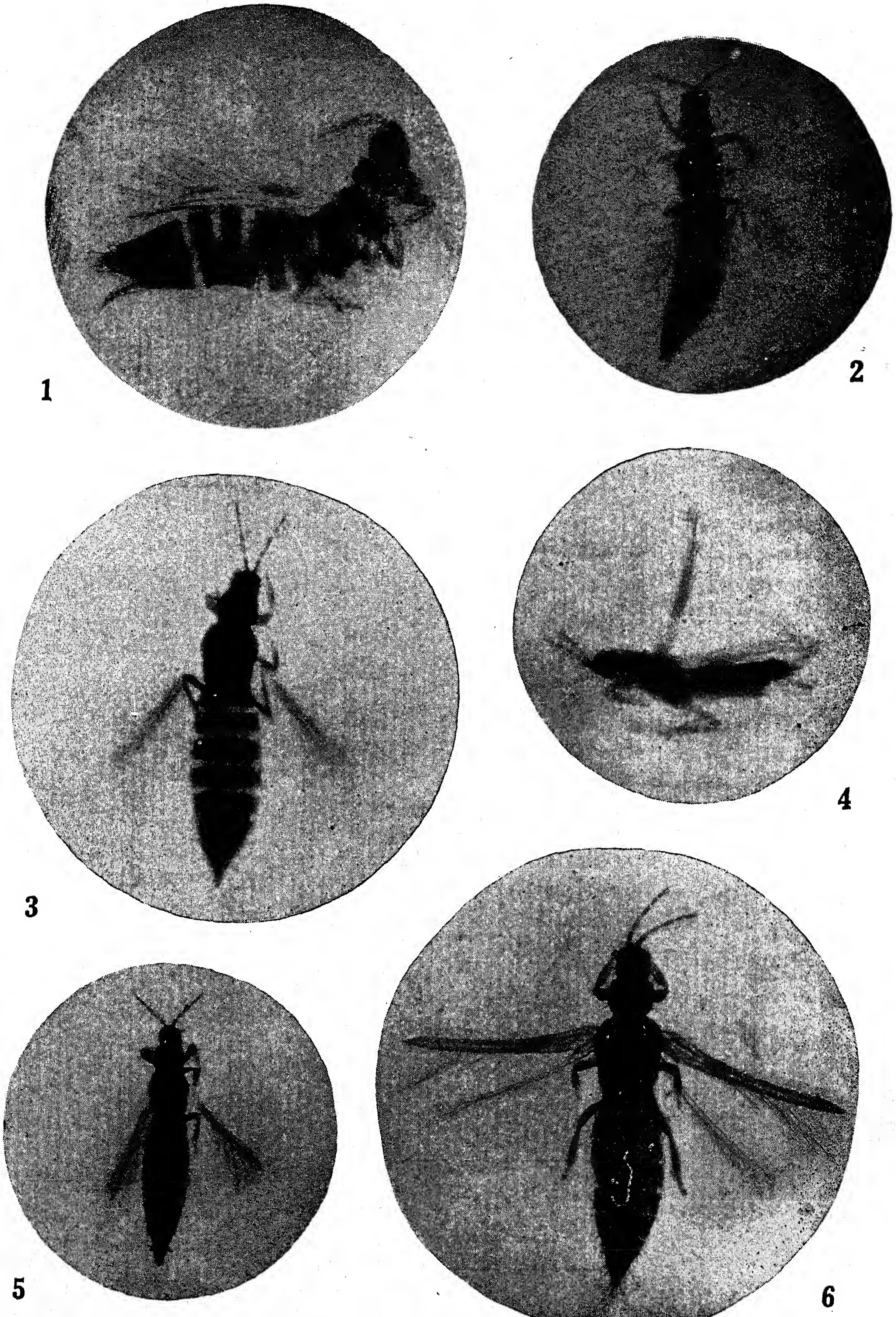


PLATE XVII

FIG. 1. Ayyaria chætophora, n. gen., n. sp., ♀.

FIG. 2. Frankliniella sulphurea, Schmutz, ♀.

FIG. 3. Tæniothrips longistylus, Karny, ♀.

FIG. 4. Tæniothrips longistylus, Karny, ♂ having both antennæ anomalous, "Ceratothripoid."

FIG. 5. Physothrips minor, Bagnall, ♀.

FIG. 6. Isoneurothrips orientalis, Bagnall, ♀.

PLATE XVIII.

FIG. 1. Isoneurothrips orientalis, Bagnall, ♂.

FIG. 2. Thrips florum, Schmutz, ♀, from Hibiscus flowers.

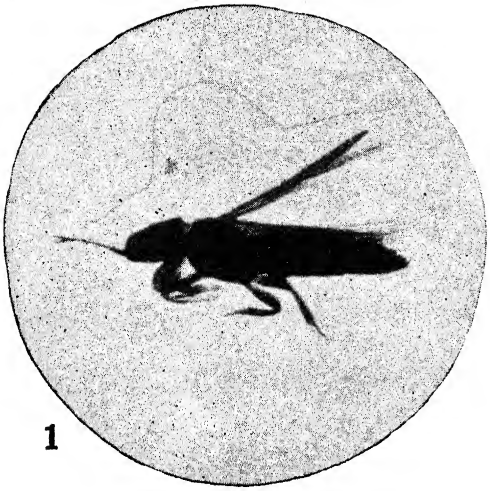
FIG. 3. Thrips florum, Schmutz, ♂, from Banana flowers.

FIG. 4. Mycterothrips setiprivus, n. sp., ♀.

FIG. 5. Anaphothrips oligochætus, n. sp., ♀.

FIG. 6. Anaphothrips ramakrishnai, n. sp., ♂.

PLATE XVIII.



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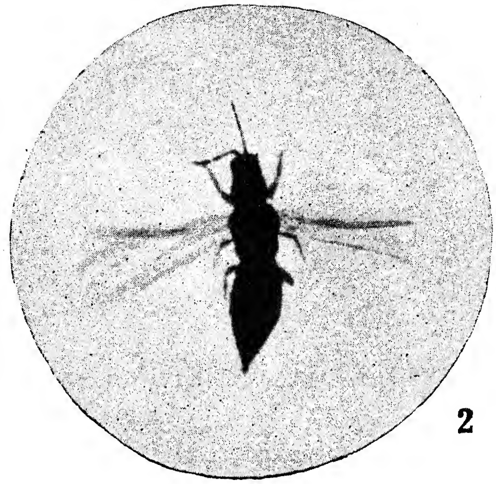

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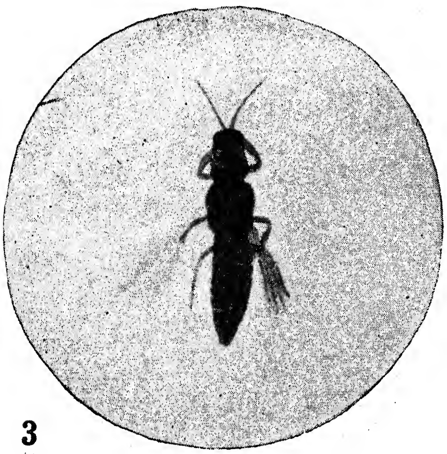

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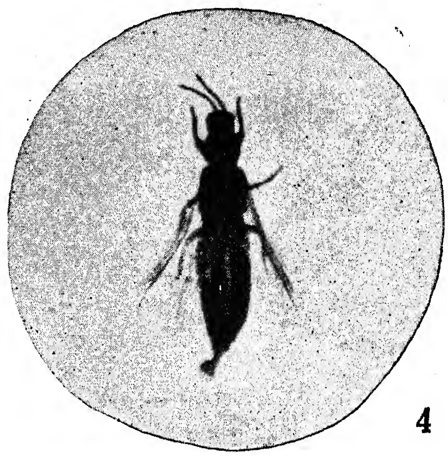

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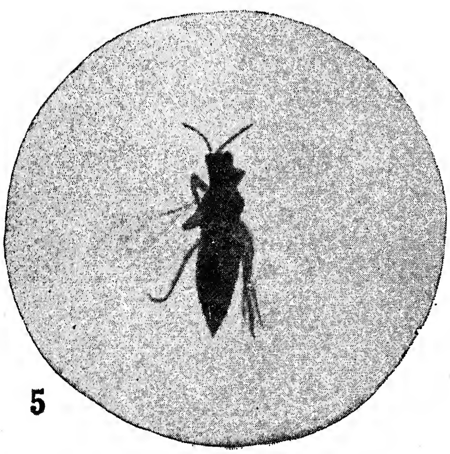

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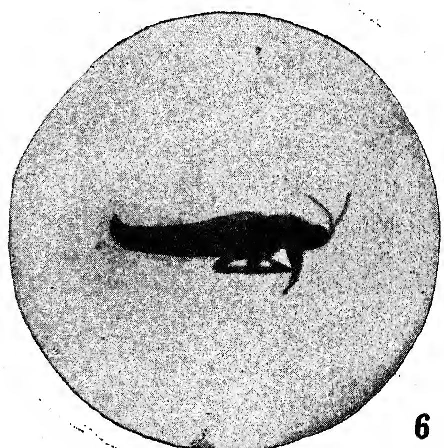

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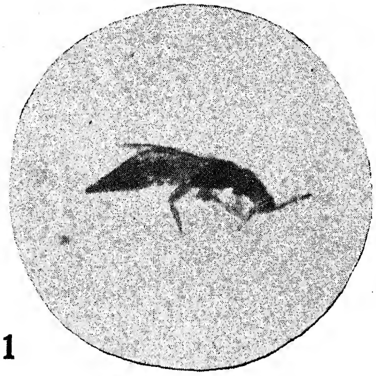
PLATE XIX.



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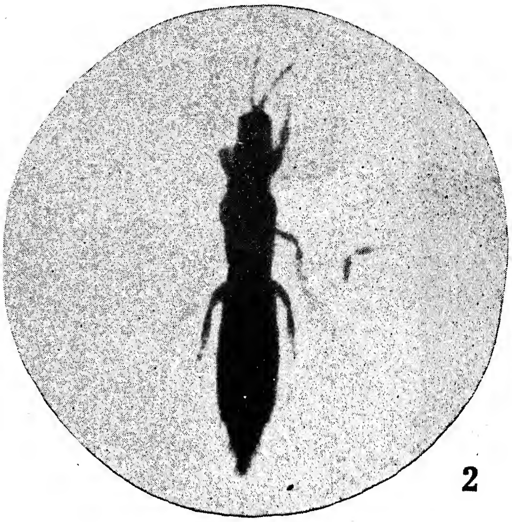

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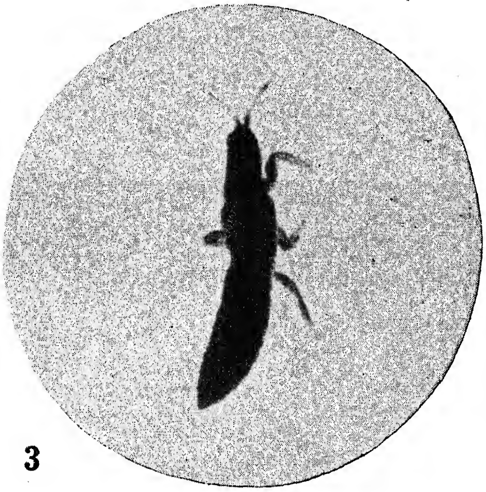

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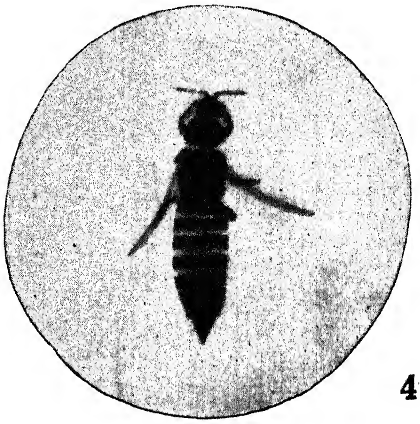

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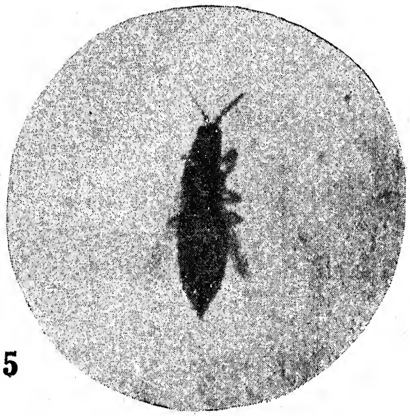

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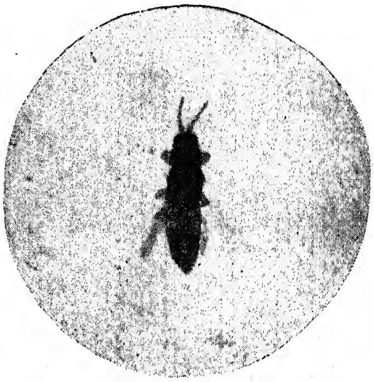

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PLATE XIX.

FIG. 1. Perissothrips parviceps Hood, ♀.

FIG. 2. Bregmatothrips binervis, Kobus, ♀.

FIG. 3. Bregmatothrips binervis, Kobus, ♀.

FIG. 4. Stylothrips brevipalpis, n. gen., n. sp., ♀.

FIG. 5. Ramaswamiahell a subnudula, n. gen., n. sp., ♀.

FIG. 6. Ramaswamiahella subnudula, n. gen., n. sp., ♂.

PLATE XX.

FIG. 1. Arrhenothrips ramakrishnæ, Hood.

FIG. 2. Dolichothrips ochripes, n. sp.

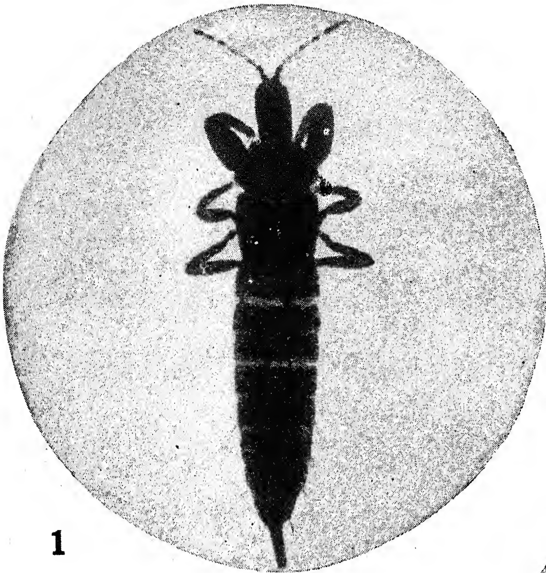
FIG. 3. Haplothrips soror, Schmutz, ♀.

FIG. 4. Rhynchothrips pallipes, n. sp.

FIG. 5. Neoheegeria indica, Hood.

FIG. 6. Eurhynchothrips ordinarius (Hood).

PLATE XX.



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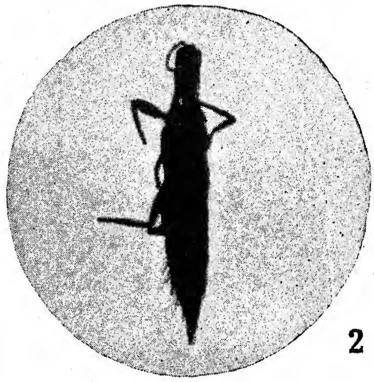

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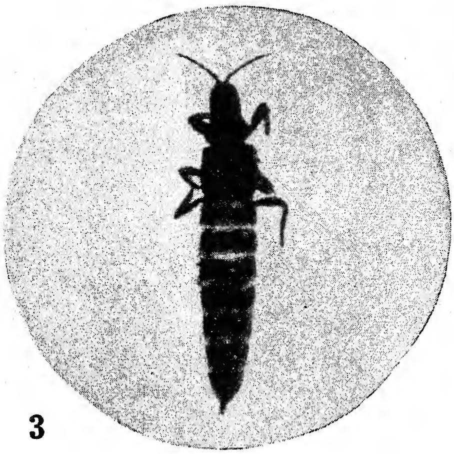

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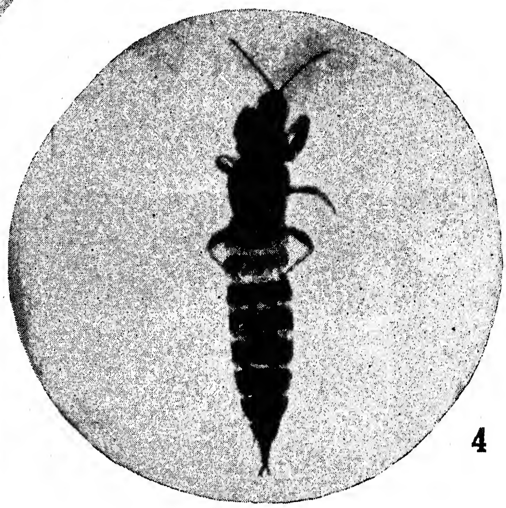

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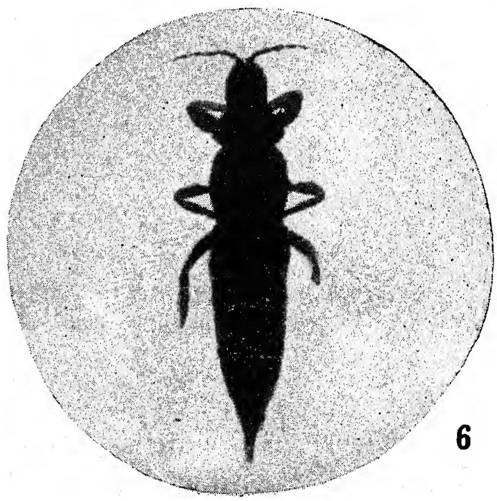

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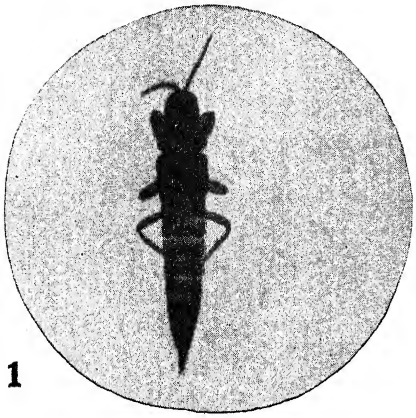
PLATE XXI.



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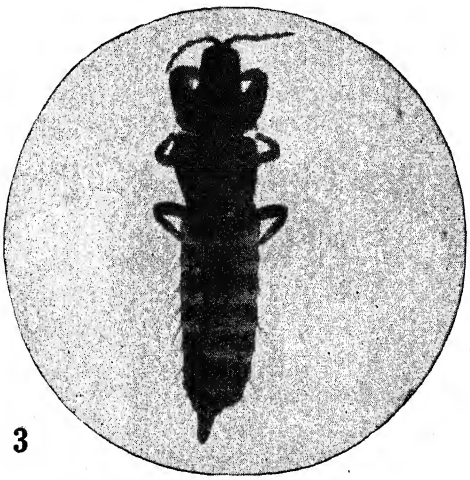

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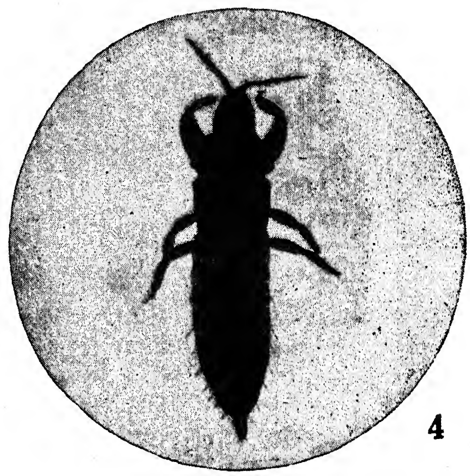

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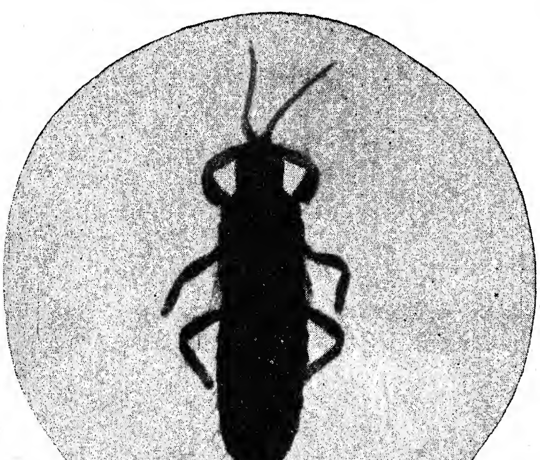

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PLATE XXI.

Fig. 1. Haplothrips ganglbaueri, Schmutz, ♂ with anomalous left antenna.

Fig. 2. Haplothrips ramakrishnai, n. sp., ♀.

Fig. 3. Trichothrips hadrocerus, n. sp., macropterous ♀.

Fig. 4. Trichothrips hadrocerus, n. sp., apterous ♂.

Fig. 5. Eothrips foliiperda, n. sp., ♀.

Fig. 6. Austrothrips cochinchinensis, Karny.

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PLATE XXII.

FIG. 1. Androthrips flavipes, Schmutz, ♀, from Ficus retusa.

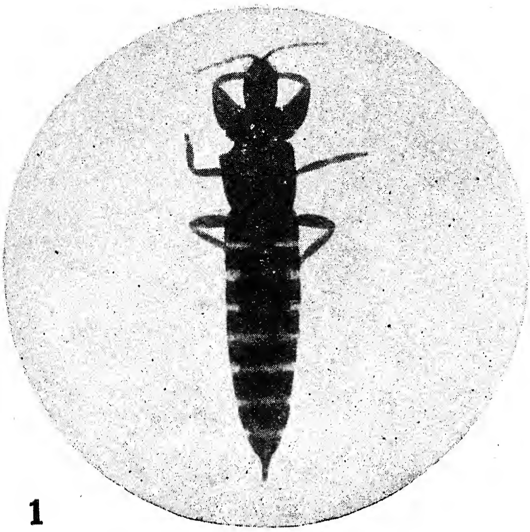
FIG. 2. Androthrips ramachandrai, n. sp., ♂.

FIG. 3. Gynaikothrips uzeli, Zimmermann.

FIG. 4. Mesothrips melinocnemis, n. sp., ♂.

FIG. 5. Mesothrips apatelus, n. sp., ♀.

FIG. 6. Ramakrishnaiella unispina n. gen., n. sp., ♂.



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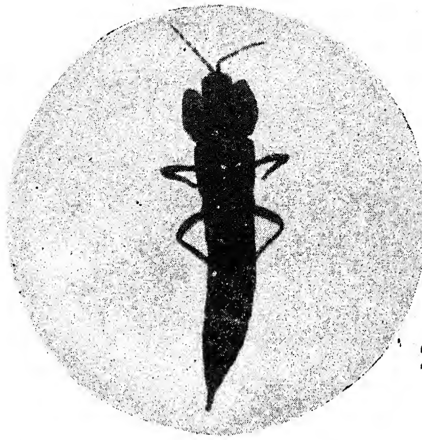

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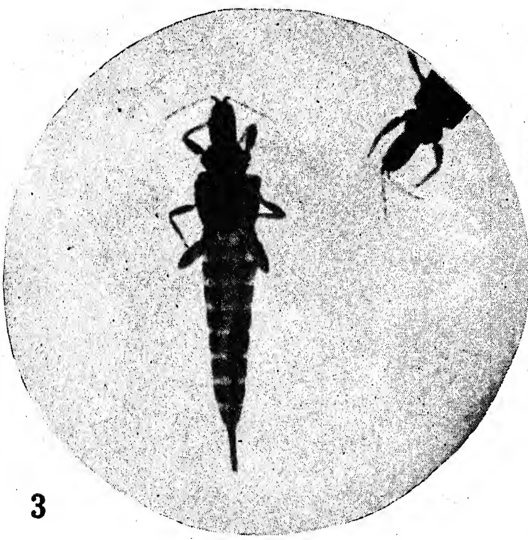

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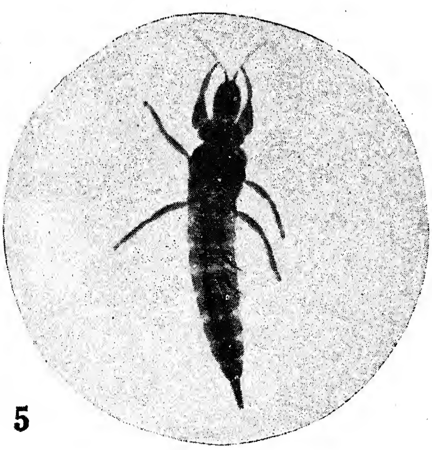

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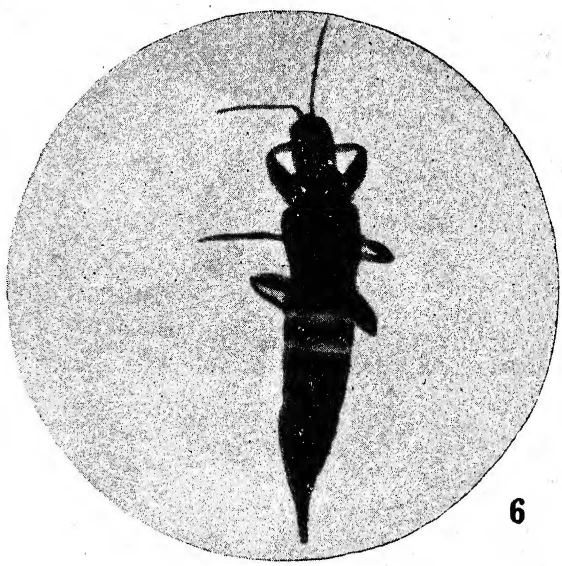

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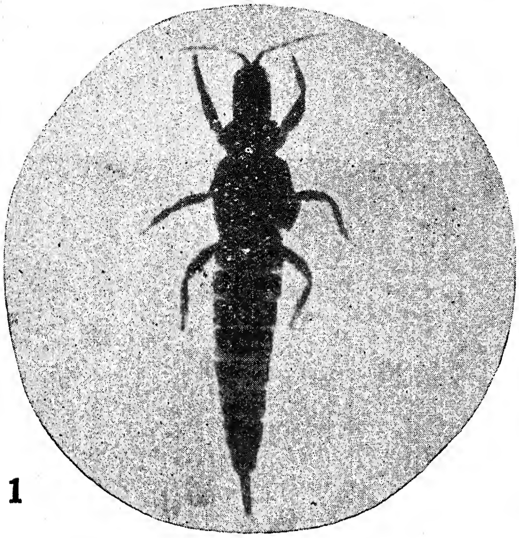
PLATE XXIII.



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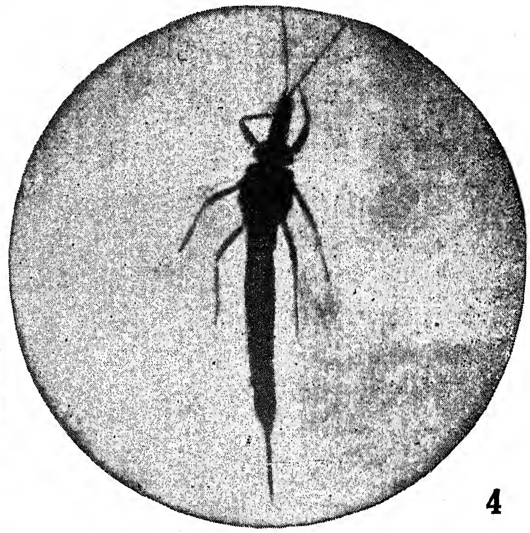

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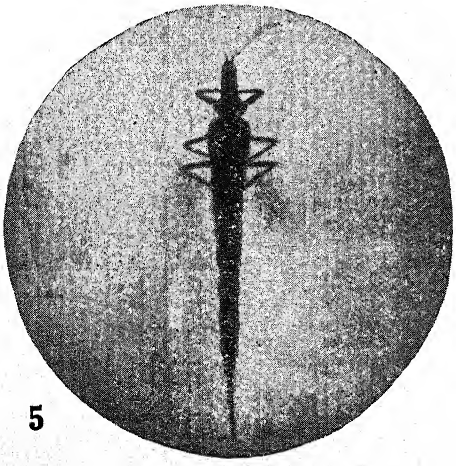

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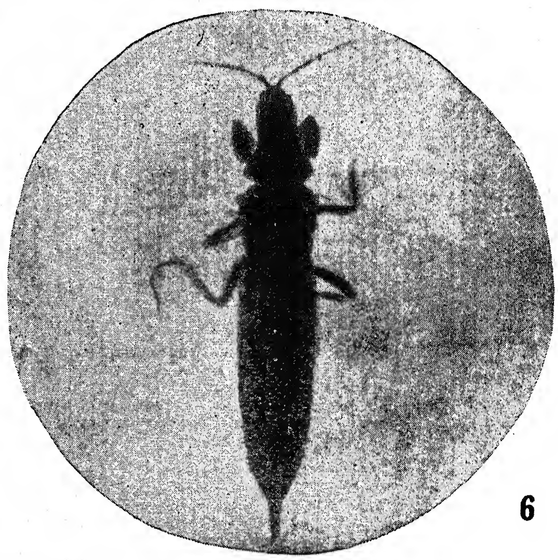

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PLATE XXIII.

FIG. 1. Gynaikothrips uzeli, Zimmermann, ♂ with anomalous short tube.

FIG. 2. Dinothrips sumatrensis, Bagnall, ♀.

FIG. 3. Dinothrips sumatrensis, Bagnall, head of a ♀ having one antenna anomalous.

FIG. 4. Gigantothrips tibialis, Bagnall.

FIG. 5. Gigantothrips elegans, Zimmermann.

FIG. 6. Gynaikothrips interlocatus, n. sp., ♀.

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Memoirs of the Department of Agriculture in India

New Species of Indian Gall Midges (Itonididae)

BY

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State Entomologist of New York

AGRICULTURAL RESEARCH INSTITUTE, PUSA

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NEW SPECIES OF INDIAN GALL MIDGES (ITONIDIDÆ)

BY

E. P. FELT, D.Sc.,

State Entomologist of New York.

(Received for publication on 5th April 1926.)

The following new species are from a most interesting lot of gall midges submitted for identification by Prof. E. Ballard, Government Entomologist, Agricultural College and Research Institute, Coimbatore, India, March 22, 1922. Particular attention should be called to the remarkable *Hormomyia subaptera* and the peculiar *Schizomyia mœruœ.* The long delay in making these identifications was due to the author unexpectedly transferring his entire energies for a time to the gipsy moth work of New York State.

CAMPTOMYIA HIBISCI, n. sp.

Male : Length 1·5 mm. Antennae a little longer than the body, sparsely haired, dark brown, with at least twenty-one segments, the fifth with a stem three-fourths the length of the cylindrical basal enlargement, which latter has a length one-fourth greater than its diameter, basally a rather thick whorl of moderately long, slender setae and sub-apically a scattering whorl of longer setae; low circumfila occur near the basal third and apically. Palpi, first segment short, sub-quadrate, the second with a length about four times its width, the third a little longer, more slender and the fourth about one-fourth longer than the third and more slender; mesonotum yellowish brown, the sub-median lines narrow, yellowish; scutellum and postscutellum yellowish; abdomen pale yellowish; genitalia fuscous; basal clasp segment rather short, broad, apically with a distinct lobe; terminal clasp segment rather long, broad, scarcely swollen near the middle and apically with a stout, somewhat recurved, chitinous spur, other structures indistinct in the preparation; halteres and legs pale yellowish; claws moderately long, stout, curved, unidentate; the pulvilli as long as the claws.

Female : Length 1·5 mm. Antennae extending to the third abdominal segment, rather thickly haired, yellowish brown, twenty-four sessile segments, the fifth with a length one-fourth greater than its diameter; terminal segment compound with a length three times its greater diameter and tapering somewhat irregularly to a narrowly rounded apex; mesonotum reddish brown; scutellum and post-scutellum apparently reddish brown; abdomen rather thickly haired, reddish yellow; halteres

coxae and legs pale straw; ovipositor moderately stout, with a length two-thirds of the abdomen; the terminal lobes narrowly oval and thickly setose.

Type Cecid. A 3255, N. Y. State Museum.

Received from Professor E. Ballard, March 22, 1922. Labelled 51, 6 IV '15, South India, Coimbatore, breeding in rotting stems of Hibiscus, Insectary. This species is easily distinguished from the other two Indian species of the genus described by the author by the short, sessile antennal segments of the female.

CAMPTOMYIA MORINDAE, n. sp.

Male: Length 1·75 mm. Antennae one-fourth longer than the body, thickly haired, light brown, the stems transparent, twenty segments, the fifth with a stem one and one-fourth times the length of the basal enlargement, which latter has a length about one-fourth greater than its diameter, a rather thick basal whorl of short, stout setae and a thick, sub-apical whorl of longer setae; low transverse circumfila occur at the basal third and apically; terminal segment reduced, the basal enlargement with a length about three-fourths its diameter, the reduced stem forming a narrowly conical appendage. Palpi, first segment irregularly sub-quadrate, with a length nearly twice its diameter, the second broader and longer, the third slender, with a length six times its diameter and the fourth a little shorter and more slender than the third, all sparsely set with rather short, stout setae; mesonotum dark brown; scutellum fuscous yellowish; postscutellum darker; abdomen rather thickly haired, dark yellowish brown; genitalia fuscous yellowish; basal clasp segment rather long, broad; terminal clasp segment short, swollen near the distal third, apically with a stout tooth, really a compound spine, both basal and terminal clasp segments with numerous long, rather stout setae externally; dorsal plate moderately long, broad, with broad divergent, lateral lobes, the latter with a length almost equal to the basal portion, obliquely truncate distally, the pair forming as it were the broad branches of a Y, the basal portions of the dorsal plate representing the lower part of the letter; ventral plate long, broad, nearly divided, the lobes being moderately broad, slightly wider near the middle, broadly rounded apically and sparsely setose; harpes chitinous, broad basally, slender apically; the toothed apexes somewhat recurved; halteres yellowish transparent; the legs a nearly uniform pale straw; claws rather slender, strongly curved, unidentate; the pulvilli longer than the claws.

Female: Length 1·5 mm. Antennae about three-fourths the length of the body, rather thickly haired, light brown, twenty-four segments, the fifth with a stem about one-fourth the length of the cylindrical basal enlargement, the latter with a length two and a half times its diameter; terminal segment more or less fused with the preceding. Palpi, the first segment sub-quadrate, with a length about twice its diameter, the second a little longer, broader, the third with a length about five times its diameter and the fourth a little longer and more slender, all

sparsely clothed with stout setae; mesonotum reddish brown; scutellum and postscutellum fuscous yellowish; abdomen mostly fuscous yellowish, the ovipositor recurved dorsally and with a length nearly equal that of the abdomen; terminal lobes narrowly oval, sparsely setose; otherwise as in the male.

Type Cecid. A 3248, New York State Museum.

The specimens were received from Professor E. Ballard under date of March 22, 1922. They were labelled 44, 22 II, 1920, Coimbatore, attacking trunk of *Morinda tinctoria*, Ballard Coll.

Schizomyia mæruæ, n. sp.

Female: Length 1·5 mm. Antennae about three-fourths the length of the body, sparsely haired, light brown, 14 segments, the fifth with a length about $2\frac{1}{2}$ times its diameter, the 13th segment with a length a little greater than its diameter, the 14th globose. Palpi: first segment broadly oval, the second about $\frac{1}{2}$ longer, the third twice the length of the second, the fourth $\frac{1}{2}$ longer than the third. Mesonotum yellowish-brown, scutellum yellowish, postscutellum darker, abdomen yellowish-brown; the ovipositor rather stout basally, with a length about twice that of the abdomen, the terminal portion slender, suggesting the needlelike tip of Asphondylia though more delicate, the terminal lobes very long, slender. This species is remarkable because of the apparent absence of a chitinized ventral plate at the base of the abdomen and presents certain intermediate characters between Asphondylia and Schizomyia. Halteres and legs mostly pale straw.

Type Cecid. A3260, N. Y. State Museum.

Received from Professor E. Ballard, March 22, 1922, labelled No. 54 misc., 26 VI '17, Coimbatore, from galls on *Mæruæ arenaria*, 18, A. A., Coll.

Asphondylia ipomœæ, n. sp.

Female: Length 2·25 mm. Antennae probably as long as the body, sparsely haired, dark brown, fourteen segments, the third segment with a length five times its diameter, the twelfth segment with a length two and a half times its diameter, the thirteenth with a length one-fourth greater than its diameter and the fourteenth globose. Palpi: The first segment irregularly sub-quadrate, the second rather broad, with a length three times its diameter, the third about twice the length of the second, slender; mesonotum dark slaty brown; the submedian lines sparsely haired; scutellum fuscous yellowish, postscutellum darker; abdomen dark yellowish brown; the ovipositor fuscous yellowish and about as long as the abdomen when fully extended; halteres, coxae and legs mostly fuscous yellowish; the claws moderately stout, strongly curved; the pulvilli as long as the claws.

Exuvium: Length 3 mm. Moderately stout, dark yellowish brown; the antennal cases extending nearly to the base of the abdomen; the wing cases to the third abdominal segment and the leg cases to the sixth abdominal segment; antennal

horns moderately stout, the curved inner edges slightly toothed, abdominal segments dorsally, each with an irregular, scattering sub-basal row of small to moderate sized teeth and a regular distal row of larger teeth; posterior segment with a sub-basal and sub-apical transverse row of spines, sparse and irregular, at each lateral posterior angle a pair of somewhat curved, stout triangular spines.

Type Cecid. A 3251, New York State Museum.

The material was received from Professor E. Ballard, March 22, 1921. It was labelled 47, Coimbatore, 25 II '22, galls on *Ipomœa staphylina*, A. G. R. Coll.

Lasioptera eriochloa, n. sp.

Female: Length 1·2 mm. Antennae extending to the base of the abdomen, thickly haired, dark brown, segments apparently varying from eighteen to twenty-one, the fifth with a length about twice its diameter, the distal segment globose: Palpi, first segment short, sub-quadrate, the second a little longer, more slender, the third one-half longer than the second; mesonotum dark reddish brown; scutellum and postscutellum brownish yellow; abdomen a nearly uniform dark brown, the segments very narrowly margined posteriorly with yellowish white; ovipositor about two-thirds the length of the abdomen when extended, the apical portion of the thickened basal part with numerous rather long, closely set spines; near the apex of the distal portion there is a thick group of rather long, somewhat slender, irregularly curved, chitinous hooks; the terminal lobes narrowly oval and sparsely setose; legs mostly fuscous straw; the tibiæ and the tarsi of the posterior pair nearly black; claws long, slender, strongly curved; the pulvilli a little shorter than the claws.

Type Cecid. A 3241, N. Y. State Museum.

The specimens were received from Professor E. Ballard, March 22, 1922 accompanied by the statement that they were reared from ear heads of *Eriochloa polystachya*. They were labelled 37, Coimbatore, 11 I '22, Y. R. Rao, Coll.

Hormomyia subaptera, n. sp.

The female described below is tentatively referred to this genus in spite of the fact that the mesonotum overhangs the head to only a moderate extent and the presence of but two low circumfila on the flagellate antennal segments. The insect is so peculiar that it is deemed advisable to give it a name although the one specimen is imperfect.

Female: Length 4 mm. Antennae probably shorter than the body, presumably with at least fourteen segments, the first broadly obconic, the second sub-globose, flattened basally, the third with a stem about one-fourth the length of the sub-cylindric basal enlargement, which latter has a length about three times its diameter; the fifth with a stem one-third the length of the sub-cylindric basal enlargement, which latter has a length of about two and a half times its diameter, sparse whorls of

rather coarse setae basally and sub-apically and low, rather stout circumfila at the basal third and apically, the loops being a little longer than the average distance between the points of insertion, the remaining segments wanting. Palpi, the first segment presumably sub-quadrate, the second long, slender, with a length about six times its diameter and with a few coarse setae; mesonotum dark yellowish brown; scutellum and postscutellum yellowish brown; abdomen reddish brown; ovipositor short, the lobes moderately broad, broadly rounded apically and with a length about three times the width; the rudimentary wings sub-orbicular, with a length less than 1 mm., hyaline; sub-costa apparently uniting with the margin at the distal third, the third vein springing therefrom joins the margin at the apex, the fifth at the distal third, its branch near the basal third; halteres moderately long apically narrowly oval; legs mostly dark and somewhat variably fuscous straw; the claws rather long, somewhat slender, moderately curved, simple; the pulvilli nearly as long as the claws.

Type A 3237, N. Y. State Museum.

Received from Professor E. Ballard, Coimbatore, March 22, 1922. Labelled 33, Snowdon Peak (Ootacamund), Nilgiris, 8300 feet, on grass, X, 1921, Y. R. Rao, Coll.

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Memoirs of the Department of Agriculture in India

New Indian Geometridae

BY

LEWIS B. PROUT, F.E.S.

AGRICULTURAL RESEARCH INSTITUTE, PUSA

Calcutta: Government of India
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NEW INDIAN GEOMETRIDAE.

BY

LOUIS B. PROUT, F. E. S.

(Received for publication on 7th April 1926.)

Subfam. **Hemitheinae.**

1. Agathia angustilimes, sp. n.

♂, 30-36 mm. Face, palpus, fillet and postorbital rim purple; crown bright green. Collar tippets and front of wing-tegulæ green, the latter otherwise purple. Body above purple, the thorax with a large central patch of green, the abdomen sometimes dark-clouded. Hindtibia not dilated. Forewing beneath with a compact flap of long scales from M over base of cell, as in *hilarata* Guen. but not quite so large.

Forewing apple-green, the markings purplish or light-brownish-vinaceous, finely edged with whitish, in places clouded with darker duller purple (variably according to the individual); costal border normal; basal patch small, almost straight-edged, reaching costa; median band from $\frac{2}{5}$ costa to slightly beyond middle of hind-margin, about 1 mm. wide, pretty uniform and only very slightly sinuous; terminal band in posterior half almost equally narrow, in anterior half still narrower; a narrow branch therefrom (slightly widening anteriorly) from R^3 to costa at nearly $\frac{4}{5}$; fringe light brownish-vinaceous.

Hindwing shaped about as in *hilarata*, or slightly less elongate; the purple border narrower than in that species, enclosing a similar, elongate green patch between SC^2 and R^3 and an additional, small one between M^2 and SM^2, the latter almost confluent with the ground-colour at fold; the darker redder mixed spot in tail conspicuous, triangular, bounded with whitish on its proximal and anterior sides.

Underside much paler, similarly marked.

Pusa, Bihar, 3 February 1915 (T. Bainbrigge Fletcher), type in coll. Brit. Mus., October 1908, paratype in coll. L. B. Prout, 10 May 1914, paratype (dwarfed by breeding), bred from *Karanda* leaves (cage No. 1050), in coll. *Agric. Res. Inst., Pusa.*

I have long known ♀♀ from the Nilgiris (in coll. Tring Mus., labelled by Warren "*Agathia hilarata* var. *angustilimes*"), but have awaited the ♂ before publishing. The non-dilated hindtibia is a striking distinction from *hilarata* Guen. and *guinaria* Moore.

Subfam. **Sterrhinae.**

2. Sterrha mesodela, sp. n.

♂ ♀, 18-20 mm. Face and palpus (except at base) black. Vertex whitish. Collar fuscous. Antennal joints not projecting; ciliation in ♂ even, about 1. Thorax and abdomen tilleul-buff, above with some blackish irroration. Hindtibia in ♂ with a pair of longish spurs.

Forewing rather narrow, termen rather strongly oblique; areole long, SC^1 from near its apex or shortly stalked beyond, R^2 rather before middle of DC; tilleul-buff, finely irrorated with blackish; cell-dot black; lines blackish; antemedian excurved anteriorly, very fine and weak except at costa; median strong, though slightly irregular, placed just beyond cell-dot, mostly parallel with termen, turning slightly baseward at costa and incurved at fold; postmedian fine, not strong, minutely punctuated on the veins, parallel with termen except for slight curves inward to costa and outward to hindmargin; subterminal slightly sinuous, with weak shades proximally and distally; fringe with blackish proximal spots opposite the veins.

Hindwing rather narrow, termen with the double sinuosity scarcely appreciable; SC^2 and R^1 stalked to almost half their length; cell-dot rather small; first line wanting, the rest continued, more sinuous than on forewing, the strong median incurved proximally to cell, sometimes touching its proximal side, the postmedian angled outward in front of SC^2 R^1.

Underside with the cell-dots present, though small; otherwise unmarked.

Kashmir: Srinagar, 5,200 feet, 21-31 May 1923, 2 ♂♂, 1 ♀; Gandarbal, 16-27 June 1923 (T. Bainbrigge Fletcher). Type (Srinagar) in coll. Brit. Mus.

The distinguishing features as compared with *sabulosa* Prout (*Seitz Macrolep.* iv. 105) and some other obscure Palaearctic species are the accentuation of the median line and especially the presence of the hindtibial spurs in the ♂, which place it in the typical section of *Sterrha.*

3. Sterrha delibata, sp. n.

♂ ♀, 24-25 mm. Near *rufaria* Hb. and *consanguinaria* Led., agreeing in antennal and leg structure. Face rufous, apparently without the black admixture found in *consanguinaria* (somewhat abraded).

Forewing slightly shorter than in the allies; colour nearly as in *rufaria* but more glossy, almost greasy-looking (the single ♀ much more rufous than the ♂♂); lines similar in position but different in expression, the median being strengthened and rather thick, the post median and subterminals weakened; fringe with appreciable though small and weak, dark dots at ends of veins.

Hindwing with termen slightly more sinuous than in the allies; stalk of SC^2-R^1 variable in length (shortest in the type, longest in the ♀); cell-dot sharp, rather more

elongate than in the allies; lines conformable to those of forewing; fringe as on forewing.

Underside similar, slightly more sharply marked.

Kashmir: Srinagar, 5,200 feet, June 1923 (T. Bainbrigge Fletcher). Type in coll. Brit. Mus., paratype ♂ in coll. *Agric. Res, Inst. Pusa.* allotype ♀ in coll. L.B., Prout.

4. Sterrha inaudax, sp. n.

♂, 19 mm. Probably nearest to *dilutaria* Hb. and *delicatula* Warr.; slightly narrower winged than both (costa of forewing slightly straighter). Antennal joints somewhat projecting, the cilia grouped in slender fascicles, the longest a little over 1. Hindtibia slender, but fringed above with long hair-scales; tarsus almost 1.

Forewing with small black cell-dot as in *delicatula*; lines weaker, the postmedian straighter, minutely dotted on the veins somewhat as in *sylvestraria* Hb. (*straminata* Tr.); subterminal and its shades much as in typical *dilutaria*; fringe with minute dots at vein-ends as in *delicatula.*

Hindwing marked much as in *dilutaria*, with minute vein-dots and fringe-dots as in *delicatula*; in the less smooth termen nearer to the latter.

Underside with the markings more or less completely reproduced, the antemedian line of forewing lost in a basal suffusion which reaches median line.

Kumaon: Muktesar, 7,000 feet, 24 April. 15 May 1923 (T. Bainbrigge Fletcher) 3 ♂♂. Type in coll. Brit. Mus.

Tring Museum has two from Dalhousie, May and June 1891.

5. Sterrha scelisca, sp. n.

♂, 24-26 mm. Face black, with lower extremity pale. Palpus black-mixed above. Vertex whitish. Antennal joints very slightly projecting, ciliation rather long (reaching 2), in very slender fascicles. Collar fuscous. Thorax and abdomen concolorous with wings. Foreleg partly infuscated; hindleg short, the tibia little thickened, little longer than femur, the tarsus short (less than $\frac{1}{2}$).

Forewing moderately elongate, apex rather acute, termen rather strongly oblique, almost straight, with the faintest suggestion of the sinuosities of *degeneraria* Hb. and allies; areole narrow, open, or closed only by point-anastomosis of SC^1 with SC^{2-5}; whitish drab, with a faint fleshy tinge; minute and inconspicuous dark irroration; a minute black cell-dot; antemdian line very weak, apparently vertical from costa, curving in cell, becoming parallel with termen; median shade weak, not thick, placed just beyond cell-dot; postmedian less weak, placed only about 2 mm. from termen, slightly incurved between the radials and between M^2 and SM^2, slightly punctuated on the veins, with scarcely appreciable lunulation between; subterminal shades almost or altogether obsolete; fringe with minute dots at vein-ends.

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Hindwing with termen almost smooth, rather strongly convex ; SC^2-R^1 moderately stalked ; cell-dot as on forewing or slightly stronger ; median extremely weak, just proximal thereto ; postmedian rather weaker than on forewing, more proximally placed, the sinuosities rather stronger ; fringe as on forewing.

Underside with hindwing slightly whiter than forewing ; both wings with cell-dot, postmedian line and generally some indication of median.

Kumaon : Muktesar, 7,000 feet, 24 April-15 May 1923 (T. Bainbrigge Fletcher), 4 ♂♂. Type in coll. Brit. Mus.

Probably more or less closely related to *indeterminata* Warr., *indecorata* Warr. and the *aversata* Linn. group ; the combination of long-ciliate antenna with weak hindleg recalls *pallidata* [Schiff.] more than any other species that I can call to mind, but shape and facies are quite different.

6. Sterrha macrospila, sp. n.

♀, 12-14 mm. Head blackish. Tongue long. Collar tinged with brown. Thorax white, mixed with blackish. Abdomen above predominantly black-brown.

Forewing with SC^1, ^{5}, ^{2}, ^{3}, ^{4} stalked, areole wanting ; white, tinged with buff ; a slight dark mark on costa at about ⅕ ; cell-dot black, rather elongate, immediately followed distally by a broad black-brown band (somewhat mixed with light violet-plumbeous scaling), which reaches hindmargin but does not quite reach costa or termen, its proximal side slightly sinuous, its distal obliquely curved outward from SC^5 about to M^1 ; subterminal line forming the distal boundary of the band, defined distally by a very fine dark line between SC^5 and M^2, then curving inward to form two thicker pale lunules on the band itself, with a deep inward tooth on fold ; fringe whitish.

Hindwing with costa rather long, apex rounded off, termen rather prominent at R^1, on account of a slight sinus between this and R^3, a still fainter concavity posteriorly, sharpening the tornus ; R^3 and M^1 stalked ; concolorous with forewing ; cell-dot rather large, immediately followed by a band corresponding to that of forewing, the dark line at its proximal side rather more differentiated than on forewing.

Underside similar, the band rather more blurred.

Bombay, September 1892 (*Davidson*), type in coll. Brit. Mus.; Coimbatore, 17 October 1914 and 1 November 1914, bred from refuse in fork of tamarind trees, paratypes in coll. *Agric. Res. Inst. Pusa.* et coll. L. B. Prout.

Related to *micra* Hmpsn. except in the suppression of the areole. It might be possible to establish a genus for this group with the areole minute or wanting, but the character has also originated independently in one or two other specialised *Sterrha.* The stalking of M^1 of the hindwing is another occasional development which I cannot yet use as generic.

Subfam. **Larentiinae.**

7. Coenotephria homophoeta, sp. n.

♀, 32 mm. Closely similar to *homophana* Hmpsn.

Forewing with the costal margin perhaps slightly more arched; proximal area tinged with brighter brown, the basal patch scarcely darkened; subbasal line less sinuous, anteriorly excurved, then almost straight; postmedian with the projection between fold and SM^2 slighter; distal area characteristically marked, the vague pale longitudinal streak of cellule 6 being replaced by a broader, shorter (longitudinally oval) and purer white spot proximal to the subterminal, and the region between R^4 and M^2 being strongly washed with rather light cinnamon; subterminal obsolescent except for two conspicuous white dots, one behind R^3, the other behind M^2.

Hindwing with a broader and more strongly differentiated pale area (sometimes almost clear white) distally to the postmedian.

Kashmir: Gulmarg, 8,500 feet, 17-24 July 1923. (T. Bainbrigge Fletcher.) Type in coll. Brit. Mus., paratype in coll. L. B. Prout; Yusimarg, 7,500 feet, 6-15 August 1923, (T. Bainbrigge Fletcher) paratype in coll. *Agric. Res. Inst., Pusa.*

C. homophana was taken with the new species at Yusimarg. The ♂ may probably reveal more structural difference.

8. Thera etes, sp. n.

♂ ♀, 28-33 mm. Face without cone. Palpus $1\frac{1}{2}$, 2nd joint heavily clothed, 3rd joint longish-moderate. Antenna with rather long pectinations (about as in *comis* Butl.). Head and body brown, more or less tinged with reddish or fawn-colour, the body paler beneath. Fore and midtibiæ and all tarsi somewhat darkened, with pale rings at ends of joints.

Forewing cinnamon-brown to russet, in the paler aberrations more tinged with vinaceous-cinnamon; markings blackish but mostly slight; subbasal line extremely fine and weak, somewhat W-shaped but with the posterior arm of the latter generally shortened; cell-mark long, strong, very oblique, merged with the anteriorly equally oblique antemedian line, which is acutely angulated at hind angle of cell, incurved but excessively fine or almost obsolete in posterior half, sometimes strong again on hindmargin as a black dot; postmedian fine, almost obsolete except anteriorly, wavy but almost parallel with antemedian anteriorly, 3·5 or 4 mm. beyond it, forming a rounded lobe outward at the radials, posteriorly rather more strongly incurved than the antemedian; median area generally very finely black-marked on the veins; sometimes also with slight dark suffusion, but never forming a solid band; subapical dash obsolescent.

Hindwing paler, greyer, with faint traces of a strongly excurved whitish postmedian line.

Forewing beneath more drab, hindwing pale, both with an indistinct, distally whitish-edged postmedian line, strongly excurved to R^3; forewing more or less dark-shaded proximally to the postmedian.

Assam: Shillong, 5,000 feet, 2 June 1924, 1 ♀, November 1924, 3 ♂♂, 2♀♀, including the type ♂ (T. Bainbrigge Fletcher). Type in coll. Brit. Mus., paratypes in coll. *Agric. Res. Inst., Pusa* et coll. L. B. Prout.

Smaller, more reddish and much more weakly marked than *comis* Butl. (1879) from Japan and *consimilis* Warr. (1888) from the N. W. Himalayas; abdomen of ♂ apparently rather less slender.

9. EUPITHECIA FLETCHERI, sp. n.

♂, 19-20 mm. Comparable with *linariata* [Schiff.]. Head and palpus paler, the face quite pale. Antennal ciliation about the same, or very slightly longer (nearly 1). Abdomen dorsally, except at base, almost uniformly reddish brown.

Forewing with the subbasal and proximal—subterminal bands less bright grown than in *linariata*, the latter band without conspicuous black maculation at the radials and with even that at the submedian fold not strong; blackish median band straighter, the white antemedian line being more gently curved, the postmedian almost straight anteriorly (slightly oblique outward at costa), posteriorly more nearly as in *linariata* (gently incurved, then running more or less obliquely outward to hindmargin); cell-dot weaker; subterminal line very fine, rather distally placed.

Hindwing without conspicuous pale postmedian band; slender and rather indistinct brownish subterminal and terminal bands and faint traces of one or two others between these and cell-dot. Underside more weakly marked than in *linariata*.

Kumaon: Muktesar, 7,500 feet, 13 September 1922 (T. Bainbrigge Fletcher), type in coll. Brit. Mus., paratypes in coll. L. B. Prout (same date) and in coll. *Agric. Res. Inst., Pusa* ("September.")

10. EUPITHECIA PROPAGATA, sp. n.

♂ ♀, 18-22 mm. Head and body grey with a tinge of brown, the thorax and abdomen above (except base of abdomen) mottled with black, beneath whitish, the abdomen with a black lateral line, which is interrupted on the first few segments. Palpus about $1\frac{1}{2}$, black-mixed on outerside. Antennal ciliation of ♂ minute (scarcely over $\frac{1}{3}$).

Forewing with termen moderatly oblique; areole single, long; grey (brownish white with numerous dark, black-irrorated lines); a slight ochreous tone about M and the proximal part of R^3 and M^1, much as in *lariciata* Freyer; cell-mark sharply black, rather narrow and elongate, almost reaching base of R^3; lines wavy, ill-defined in proximal region; the subbasal and antemedians angled outward in cell;

median and postmedian with two finer and weaker lines between them, oblique inward from costa, sharply angled subcostally, oblique outward to a second acute angle at R^1, thence nearly parallel with termen, though very slightly inbent, the median on M, the postmedian about fold; the median—as in other similarly marked species—touches the hinder end of the cell-mark; the postmedian is double, the outer very fine, accentuated by slight dashes on the veins; sub-terminal very fine, whitish, only feebly crenulate, weak between the medians, slightly expanded subtornally, its proximal dark shades generally stronger than its distal; longitudinal black interneural dashes commonly developed between subterminal and termen; terminal line narrowly interrupted at the veins; fringe dark-spotted opposite the veins.

Hindwing rather elongate costally but not exceptionally narrow; whiter than forewing except at abdominal margin, where there are a dark subbasal spot and the beginnings of lines, and distally, where a narrow dark subterminal line (or band) and a whitish subtornal dot are generally well developed, other markings generally slight, but rather variable; cell-dot almost obsolete; terminal line and fringe as on forewing.

Underside rather paler, forewing slightly suffused, hindwing clearer, both with conspicuous cell-dot and generally well marked, curved postmedian and proximal-subterminal bands; terminal line and fringe-spots rather variable in expression.

Kumaon: Muktesar, 7,500 feet (including the type ♂ and allotype ♀, in coll. Brit. Mus.) and Bhimtal to Muktesar, 5,000-6,000 feet, a good series collected by Mr. T. Bainbrigge Fletcher, Imperial Entomologist, September 1922. Also a ♀ in coll. Tring. Mus. from Kashmir Valley, 7,000 feet, 4 August 1902 (Col. Ward).

11. SYZEUXIS HETEROMECES, sp. n.

♂, 19 mm. Nearest to *seminanis* Prout (*Nov. Zool.* XXXIII, 13), particularly in the small size and the possession of a well-developed areole, SC^1 arising rather far proximad and anastomosing very shortly with the stalk of the other subcostals, nowhere approaching C; R^1 from areole. Antennal pectinations rather long.

Forewing with termen very oblique, slightly but appreciably sinuate anteriorly and posteriorly, rather prominent at R^3; coloration as in *seminanis*, irroration in places rather coarse; a small, indistinct cell-dot; costal edge dotted and streaked with fuscous, the streaks long, placed at base and at origin of the two principal spots; distinguished by the form of these spots, which are oblong rather than triangular or linear, being scarcely broader at C than at their posterior ends (just behind cell-fold and at R^2 respectively), here well over 5mm. in width; thinner and weaker marks opposite them from fold (SM^1) to hindmargin, faintly connected with them by incurved antemedian and postmedian lines across the wing; a faint dark subterminal indicated in places, arising from a small costal patch; a still smaller costal spot close to apex; termen and fringe interruptedly dark, as in the allies.

Hindwing with the band nearly reaching costa, relatively broad, especially in posterior part, distinguishable at once by being strongly angled outward about R^2.

Sikkim: Turzum Tea Estate, Nagrispur, near Darjiling (O. Lindgren), type in coll. Brit. Mus., presented by the *Agric. Res. Inst., Pusa.* Also a ♂ from Sikkim and one from the Khasis in coll. Tring Mus.

Subfam. **Geometrinæ.**

12. Heterolocha lonicerae, sp. n.

♂ ♀, 28-30 mm. Face slightly-sloping, loose-haired below. Palpus intermediate in length between those of *phœnicotœniata* Koll. and *falconaria* Wlk. Antenna of ♂ pectinate to about the 30th joint, the branches long (as in the allies). Head and front of thorax dark olive-fuscous, base of palpus (especially in ♀) yellower; the rest of the body dirty olivaceous, with some darker suffusion.

Forewing intermediate in shape between *aristomaria* Wlk. (? =*laminaria* H.-Sch.) and *falconaria* Wlk., being a trifle broader than in the latter, with the termen almost as oblique, straight, the apex acute, but not produced; SC $^{1\cdot2}$ coincident, from stalk of SC $^{3\text{-}5}$, anastomosing shortly with C, the connective bar to SC $^{3\text{-}4}$ (figured by Hampson, *Faun. Ind. Moths*, iii, fig. 97) generally wanting, in the ♀ allotype, however, not only present but capturing SC^3 (as in a few known aberrations of the allies), so that the venation could be superficially expressed as SC $^{1\text{-}3}$ stalked; their stalk arising out of that of SC $^{4\cdot5}$; R^2 (as in the allies) from before middle of DC; in ♂ deep olive-buff, in ♀ generally almost lemon-yellow, in aberrations more approaching the ♂; costal margin at base broadly tinged with red-brown, afterwards chequered, pale and dark; markings grey, shaded with red-brown or purple-brown, much as in *aristonaria*, the cell-ring large, oval, distinct; antemedian line subobsolete, excepting its costal spot, behind which there appears to be an outward bend as in *aristonaria*; apico-costal mark elongate, extending on to the fringe as a costal dot; postmedian line almost or quite obsolete in front of R^1, punctiform at radials, then more continuous, at R^1 rather further from apex than in *falconaria*, posteriorly placed as in that species, very gently incurved and accompanied distally by indistinct shading, in the ♂ also by an ill-defined blotch between R^3 and M^2.

Hindwing with termen slightly less straight than in *falconaria*; concolorous with forewing, base and costal area a little paler; cell-spot greatly reduced, not or scarcely pupilled; postmedian rather near it, fine but almost complete, only weakened about R^1, here bluntly angled, thence straight or faintly incurved; shade distally to it complete, though generally narrow.

Underside in ♂ yellower than above, in both sexes coarsely irrorated and strigulated (except on posterior part of forewing) the strigulæ suffusing most of proximal area of forewing and proximal-costal area of hindwing; markings strong, the clouds beyond postmedian extended, especially on forewing tornally.

Assam : Shillong, 2 ♂♂, 8 ♀♀ (T. Bainbrigge Fletcher), bred August-October 1919, the type ♂ disclosed on 16 September ; type ♂ and allotype ♀ in coll. Brit. Mus., paratypes in coll. L. B. Prout et coll. *Agric. Res. Inst., Pusa.*

Larva on honeysuckle. Pupa moderately robust, highly polished, yet minutely shagreened, leg-cases rather long, cremaster with 8 hooklets, central pair stoutest, strongly curved at tips ; red-brown, the intersegmental bands of abdomen and narrow stripes on the wing-and leg-cases light, the rest dark, often almost blackish, thorax spotted with black. In a slight net-work in loosely rolled leaf of the food-plant.

Since preparing the above description I have discovered that *cinerea* Warr. (*Nov. Zool.* iii. 320, unaccountly described as *omiza* and cited by Hampson, *Journ. Bom. Nat. Hist. Soc.* XI. 715, as *Hypocrasis*) is apparently a larger, more dark-grey, less variegated form of the same species. But as it was founded on a single ♂, dated March 1893, and has never yet been matched, I have decided to risk creating a synonym rather than leave the honeysuckle species inadequately known or refer to it under a doubtfully applicable name. I have suggested that the variation might prove seasonal, but Mr. Bainbrigge Fletcher considers this improbable.

13. Leptomiza parableta, sp. n.

♀, 44 mm. Face rufous. Palpus bright ochreous, mixed above with rufous. Vertex and front of thorax light yellow-brown ; thorax posteriorly with abdomen, more mixed with rufous ; body beneath bright ochreous.

Forewing rather broader than in the type species (*calcearia* Walk.), termen anteriorly less oblique than posteriorly, the teeth at R^1 and R^3 not very strong ; SC^1 arising out of C (*i.e.* its primitive base wanting), anastomosing with SC^2 ; light brown of varying shades (much as in *bilinearia* Leech but with rather copious greyish irroration), the median area yellowest, the distal suffused with pale violaceous, which becomes dominant at apex ; extreme costal edge mostly violaceous ; a weak dark cell-dot ; lines indistinctly dark, edged on their reverse sides with whitish violaceous ; antemedian very oblique outward from costa, bent at a right angle (or still more acutely) at SC, thence less oblique than termen ; postmedian slightly more oblique than termen ; fringe irregularly darkened in middle, pale violaceous at tips.

Hindwing with termen weakly crenulate, slightly bent at R^3 ; postmedian line continued medially, rather less straight than in *bilinearia ;* a fine and shadowy greyish line midway between this and termen ; the violaceous distal shading more restricted than on forewing, a moderate terminal band retaining the brown colour.

Underside rather brighter, the irroration coarser, the cell-dot of forewing and the lines of both wings sharply developed, the second line of hindwing slightly punctuated on the veins ; the whitish violaceous shade confined to an apical patch on forewing ; hindwing with small darker violaceous patches at apex and termen.

Masuri, July-October 1922 (Mackenzie). Type in coll. Brit. Mus., presented by the *Agric. Res. Inst., Pusa.*

I have for many years possessed a smaller slightly paler ♀, merely labelled " N. W. India." Very similar to *bilinearia* Leech, from W. China, possibly a race, but more variegated, more irrorated, the lines of forewing less parallel, that of hindwing more curved, etc. The venation is probably variable, as the two *bilinearia* known to me differ considerably Leech's ♂ type having SC^2 of the forewing anastomosing with SC^1 at the point where the latter leaves C, while an Ichang ♂ in the Tring Museum has SC^1 and SC^2 well separate, the former anastomosing with C.

14. Nychiodes languescens, sp. n.

♂ ♀, 44-45 mm. Remarkably like a rather light *palaestinensis* F. Wagner (*Iris* XXXIII. 112, t. IV) or especially—is the postmedian line—*antiquaria* Stgr. (as figured by Wagner, *l. c.*). Palpus slightly shorter and blacker.

Forewing with $SC^{1 \cdot 2}$ coincident, not (as in *obscuraria* Vill.) stalked; the black lines obsolete, except as inconspicuous vein-dots, but with their position made prominent by accompanying fine pale lines; antemedian excurved in cell but without the posteriorly oblique pose of that of *obscuraria;* postmedian about as in the cited figure of *antiquaria.* Hindwing with suggestion of a thick, ill-defined, oblique black antemedian line from that of forewing to abdominal margin just proximally to middle, postmedian less punctiform than on forewing, scarcely bent at R^3, oblique outward behind fold; a very fine pale distal edging to the postmedian.

Underside as in a light *palæstinensis* but with the fine pale postmedian line rather better expressed.

Kashmir: Srinagar, July 1923 (T. Bainbrigge Fletcher). Type ♂ in coll. Brit. Mus., allotype ♀ in coll. *Agric. Res. Inst., Pusa.*

May prove a much smaller, darker form of *N. confusa* Warr. (*Nov. Zool.* IX. 367), founded on a single, rather poor ♀ from Chitral; but the termen of forewing is scarcely so oblique, the cell-spots beneath are reduced, the costal spot of postmedian line wanting. Warren's *confusa* may probably have to sink to *antiquaria* Stgr.

15. Abraxas diastema, sp. n.

♂, 38-43 mm. Face and palpus fuscous and blackish, the palpus at base pale and yellowish. Antenna with the joints scarcely projecting, fascicles of cilia rather over 1. Collar, patagia and tegulæ dull orange. Abdomen dull orange, with dorsal, lateral (two irregular series) and subventral black spots. Hindtibia not greatly dilated, with a slender hair-pencil in groove; hindtarsus about two third tibia.

Forewing shorter than in *martaria* Guen., with termen less oblique; venation normal (SC^1 running into C); white; markings glossy grey, slightly more brownish than the neutral grey (or faintly bluish grey) of *martaria*; cell-spot round, about

3 mm. in diameter, not appreciably cut with white on DC; an almost complete, rather broad (2-3 mm.) band proximally to it, but not quite confluent, running from costa to SM^2, irregularly constricted in places and succeeded by a dot at hind-margin; outer band of spots double, irregular, rather heavy, in the type predominantly confluent, in the paratype less so; postmedian costal spot broad anteriorly, tapering, usually succeeded by, or confluent with, a smaller spot on R^1; other (smaller) costal spots inconstant; terminal band of confluent spots filled in with black interneural dots and nearly reaching apex, in the type partly confluent in middle with the subterminal, in the paratype more separate, in either case leaving clear a somewhat oblique apical spot; the orange-mixed basal patch normal; the posterior outer one broad, but not bright, being merged in the grey bands, yet with a rather distinct, erect brown streak at its proximal side, nearly reaching fold.

Hindwing with costal margin not dilated at base, termen faintly waved; basal patch present, though very small; cell-spot very small (on right wing of type obsolete); antemedian band represented by a macular, inwardly oblique remnant between abdominal margin and M, strongest and brown-mixed close to margin; postmedian row of spots single on first three or four veins, double on M^1, double and confluent behind, here mixed with orange-brown in distal part and accompanied distally by a third grey band between abdominal margin and M^2; a (perhaps inconstant) subapical spot in cellule 7; terminal series slightly less confluent and more lunulate than on forewing.

Underside similarly marked but without the orange.

Assam: Cherrapunji, October 1916 (native collector). Type ♂ in coll. Brit. Mus.; paratype in coll. *Agric. Res. Inst., Pusa.*

A few small, asymmetrical or inconstant spots are not mentioned in the above description, but the two specimens do not suggest that the species is a very variable one.

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Memoirs of the Department of Agriculture in India

Description of Laspeyresia stirpicola, n. sp. (Lepidoptera)

BY
E. MEYRICK, F.R.S.

With a short note on the Life-history and Status

BY
RAI BAHADUR C. S. MISRA, B.A.

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DESCRIPTION OF LASPEYRESIA STIRPICOLA, n. sp. (LEPIDOPTERA)

BY

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with a short note on the Life-history and Status

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LASPEYRESIA STIRPICOLA, n. sp.

♂♀, 12-15 mm. Head, thorax grey more or less speckled dark and pale. Palp whitish partially suffused or speckled grey. Fore wings elongate, somewhat dilated, termen somewhat obliquely rounded, dark grey, more or less whitish-speckled; costa blackish-tinged, with about eleven groups of 2-4 very fine whitish strigulæ; very oblique dark or blackish strigae from costa at about middle and two-thirds; an oblique pale blotch from dorsum beyond middle very obscurely indicated, its anterior edge limited by a suffused blackish streak, becoming obsolete towards dorsum; some irregular very obscurely leaden-metallic strigea from costa posteriorly, in ♂ obscured by a patch of whitish suffusion towards costa beyond cell; ocellus laterally edged leaden-metallic, containing three somewhat elongate black dots, above these three others less marked forming with them a rather curved series; a small dark apical spot; cilia grey with rows of white points. Hindwings dark grey, cubital hair-pecten whitish; cilia grey-whitish, suffused grey on outer half, a dark grey basal shade.

4 examples. An obscure insect, allied to *Jaculatrix.* Locality : Daltonganj.

Life-history. Eggs are laid in the axil of leaf-buds and larvæ tunnel into the stem reaching the pith, on which they feed. The hole of entry of the larva into the stem is quite conspicuous on account of scarlet coloured grannules of resin. The full fed larva (fig. 2) is 11-12 mm. long, 2.30-2.50 mm. broad. It has a shining dark, chocolate-brown, heavily chitinized head, with a triangular excavation in front. The mandibles are very powerful. The prothoracic dorsal plate is well chitinized and has a median longitudinal lighter streak and is armed with a few whitish, porrect hairs. The rest of the body is creamy yellow, and armed with

hairs arising from brownish tubercles. When full fed the larva makes a silken gallery and pupates in it. The pupa (figs. 6, 7) is light brown in colour, with black eyes and prominent thoracic segments. The abdominal segments have two rows of short spines near each end, the anal segment has a few short hairs.

Parasites. In a caterpillar collected from Daltonganj three triangulinids of Strepsiptera were discovered, two of them in the region of head and one in mesothorax. The caterpillar was cleaned in potassium hydroxide and stained with eosin. So far this is the single instance of its kind, examination of adults has not revealed any triangulinids or adult Strepsiptera.

Status. During a visit to Daltonganj in May 1925, the abnormal presence of these lepidopterous larvæ, boring into the shoot of pollarded *Butea frondosa* (Palas), was first noticed. Practically every Palas tree in the locality was more or less affected and in some branches as many as seven borers were found. The growth is stunted, galls are produced, bark becomes rough and hard and there is considerable outflow of resinous matter and the tree becomes unfit for propagation of lac. This insect may well be regarded as a serious pest of *Butea frondosa*, a tree used extensively for lac cultivation.

EXPLANATION OF PLATE XXIV.

Laspeyresia stirpicola, Mey.

1	Borer	Dorsal view	× ·16
2	Borer, immediately before pupation	Lateral view	× ·16
3	Mandible of the borer	....	× ·120
4-5	Spiracles of the borer	....	× ·300
6	Pupa	Dorsal view	× ·16
7	Pupa	Ventral view	× ·16
8	Adult moth	Dorsal view	× ·12
9	Triangulinids within the larva of the borer (much enlarged).	....	....
10	Triangulinid	Dorsal view	× ·300

PLATE XXIV.